UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
SOUTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION

Proceedings of

NINTH

COTTONSEED PROCESSING CLINIC

Sponsored Jointly

by

Southern Utilization Research and Development Division

and

Mississippi Valley Oilseed Processors' Association, ~~Inc.~~

FEBRUARY 15-16, 1960

New Orleans, Louisiana

CONTENTS

FOREWORD

These proceedings report the information presented at the Ninth Cottonseed Processing Clinic. Cosponsored by the Mississippi Valley Oilseed Processors' Association, Inc., and the Southern Utilization Research and Development Division, the clinic was attended by more than 100 representatives of the cottonseed industry, associated industries, manufacturers, federal and state laboratories, as well as staff members of the Southern Regional Research Laboratory.

The proceedings contain reports on: The latest commercial practices for cottonseed mill cooking operations; cottonseed cooling and cleaning; oil color and yield controls; cottonseed protein quality control; linters utilization; and the latest research developments in cottonseed processing. Important to the conference were discussions on the need for continued research in cottonseed processing procedures to make better products more economically.

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NINTH COTTONSEED PROCESSING CLINIC

at the

Southern Regional Research Laboratory
New Orleans, Louisiana

in cooperation with

MISSISSIPPI VALLEY OILSEED PROCESSORS' ASSOCIATION, INCORPORATED

February 15-16, 1960

PROGRAM

February 15, 1960—9:30 a.m. **Auditorium—Third Floor**			**R. M. Persell**, SU, Chairman
I.	9:30 a.m.	Opening Remarks	**C. H. Fisher**, Director, SU **Robert Patterson**, Chairman Research Committee, MVOPA
II.	10:00 a.m.	Need for Research in Cottonseed Processing	**Garlon Harper** National Cottonseed Products Association
	10:30 a.m.	Intermission	
III.	10:50 a.m.	How to Cook Cottonseed Meats for Best Results	**H. D. Fincher** Anderson, Clayton & Co.
IV.	11:10 a.m.	Investigation of Changes in the Nutritive Quality of Cottonseed Meal During Processing. Relative Effect of Gossypol and Carbohydrates	**V. L. Frampton** Industrial Crops Laboratory, SU
V.	11:30 a.m.	Protein Control of Meal Shipments	**W. G. Quinn** Buckeye Cellulose Co.
VI.	11:50 a.m.	Panel Discussion	**V. L. Frampton**, Moderator Industrial Crops Laboratory, SU
	12:30 p.m.	Lunch at Laboratory	
February 15, 1960—1:30 p.m.			**E. L. Patton**, Chairman Engineering & Development Laboratory, SU
VII.	1:30 p.m.	Economics of Color in Cottonseed Oil	**Porter A. Williams** Wesson Oil & Snowdrift Co.
VIII.	1:50 p.m.	How Color Becomes Fixed in Cottonseed Oil	**W. A. Pons, Jr.** **Industrial Crops Laboratory, SU**
IX.	2:10 p.m.	Hidden Oil Losses	Report of Committee **J. H. Brawner**, Chairman Wesson Oil & Snowdrift Co.
X.	2:30 p.m.	Panel Discussion	**J. H. Brawner**, Moderator
February 16, 1960—9:30 a.m.			**Lawrence Hodges**, Chairman Program Committee MVOPA
XI.	9:30 a.m.	Improved Seed Cooling	**Walter Johnson** Memphis Cotton Oil Mill
XII.	9:50 a.m.	Seed Cleaning	**E. A. Gastrock** Engineering & Development Laboratory, SU
	10:10 a.m.	Intermission	
XIII.	10:30 a.m.	Panel Discussion	**E. A. Gastrock**, Moderator
XIV.	11:30 a.m.	Evaluation of the Possibilities for Increasing Utilization of Linters	**Charles Montague** Buckeye Cellulose Corporation
XV.	Noon	Committee Reports	
XVI.	12:15 a.m.	Resume' and Announcements ADJOURNMENT	
	12:30 p.m.	Lunch at Laboratory	
	Afternoon:	Tour of Laboratory and Visits with SU Personnel	

INTRODUCTORY REMARKS

R. M. Persell
Southern Utilization Research and Development Division
New Orleans, Louisiana

I am very pleased to serve as chairman of the Ninth Cottonseed Processing Clinic. It is my privilege to join Dr. C. H. Fisher and the Southern Regional Research Laboratory in welcoming you. This is the ninth in a series of conferences held on commercial methods of cottonseed processing and research on problems of the cottonseed processing industry. Each conference has been sponsored jointly by the Mississippi Valley Oilseed Processors' Association, Incorporated, and the U. S. Department of Agriculture.

I hope the Ninth Clinic will prove to be very successful and mutually profitable to all, as I am sure it will. If I or any members of the Southern Laboratory can be of assistance to you, please feel free to call on us. We have arranged for lunches here at the Laboratory, and a tour of our Laboratory on Tuesday afternoon. Everything will be done to make your visit a very pleasant one. I will now call on Dr. C. H. Fisher, Director of this Laboratory and the Southern Utilization Research and Development Division, for opening remarks.

WELCOMING ADDRESS

C. H. Fisher
Southern Utilization Research and Development Division
New Orleans, Louisiana

Mr. Chairman, Members of the Mississippi Valley Oilseed Processors' Association, and other members of the conference:

We are very happy to see so many of you here this morning for the opening of the Ninth Annual Cottonseed Processors' Clinic. Looking around, I see a number of you who have been attending these clinics from the beginning; it's always a pleasure to renew old acquaintances. Your presence proves to me that you like these meetings and find them worthwhile. I also see some new faces. I want to extend an especially cordial welcome to all of you on behalf of the Southern Division and our staff.

I hope that all of you will find the sessions so profitable that you will be returning nine and ten years from now.

Back of our welcome to you, there is a real spirit of hospitality and pleasure at having you with us. There is even more in it than that, however. We feel that these meetings have concrete and definite advantages for the Southern Division. There is a good possibility that you give us more than we give you. From you we obtain a valuable new slant on the work we have in progress, and a clearer picture of the problems of the oilseed processing industry to guide us in planning new research projects.

The research scientist in the laboratory, and the manufacturer who adapts research findings to full-scale operations in a commercial plant, are both important in bringing new and better products to the consumer. Both are extremely important to each other. The scientist working on cottonseed can develop new information, new products, and new processes, but until you and others in the cottonseed processing industry adopt them, and put them to work in your plants, no one derives the full benefit from the research.

As you are aware, the objective of our work on cottonseed and other oilseeds is a practical one, namely, to gain new information which will enable you to operate more efficiently, give the consumer new and better products, provide a bigger market for cottonseed, and better returns for the farmer who grows the seed, the processor, and everyone concerned with the industry.

Members of the Mississippi Valley Oilseed Processors' Association have always shown a strong interest in our research developments. This attitude is most encouraging to us; we appreciate very much the cooperation and support you have given the Southern Division.

Because of this interest, I think you might like to have a brief listing of some of the pro-

jects on which we have been busy since your meeting last year. Several of these projects promise new markets for cottonseed oil, and some of them bear on processing improvements.

One new development is a cocoa-butter-like fat for confectionery use developed in cooperation with the National Confectioners' Association. This new product is prepared from hydrogenated cottonseed oil and commercial triolein by a process of interesterification and solvent fractionation. It has physical properties very much like cocoa butter, and is compatible with the latter in confectioners' coatings. This product appears promising and it might provide an important new market for domestic oil, perhaps as much as 100 to 200 million pounds a year.

Use of the acetoglycerides, another product from cottonseed oil, in cosmetics is growing to such an extent that the technical editor of "American Perfumer and Aromatics," the technical and trade journal of the cosmetics industry, requested an article reviewing our work on these fats and their possibilities for cosmetics manufacture. Several firms are already manufacturing the acetoglycerides commercially. Also during the year the Surgeon General granted permission for the use of acetoglycerides in coatings for almonds and peanuts, and the Quartermaster Food and Container Institute is experimenting with them for use in glazes and coatings for candies.

Probably you have heard that one company is now manufacturing methyl esters from cottonseed oil soapstock at the rate of 15 million pounds a year for stock and poultry feed, using a process developed by the Southern Division. This company is also working on production of esters of higher quality for plastics manufacture and other industrial uses.

Working toward further industrial uses for cottonseed oil, we have determined the effect of operating conditions on the migration of double bonds during the hydrogenation of an oleate. This information may be useful in the preparation of food products and dibasic acids and other chemicals for industrial use.

We have demonstrated in the laboratory that two products from cottonseed oil are promising as plasticizers. These are epoxidized morpholides of cottonseed fatty acids and N-bis(beta-acetoxyethyl) amides. These could prove to be important new outlets for cottonseed oil. Plasticizers represent a market of several hundred million pounds.

Turning to problems more immediately affecting the processing of cottonseed oil and meal, we have pursued our studies on the problems of color, gossypol, and nutritive values. Oils of good color, flavor, and stability have been produced from badly offcolored oils when alumina was substituted for Fuller's earth, the conventional bleaching agent. Also, we have made progress toward determination of Halphen acid in cottonseed oil. This acid may affect the color of the oil, and have a bearing on one type of discoloration of eggs from hens fed cottonseed meal.

We have also made progress in developing methods for determining the nutritive value of cottonseed. One of these is a method for the rapid determination of lysine. The method involves a chemical treatment of the meal which makes possible spectrophotometrical evaluation. A determination may be completed within 24 hours. The method may find widespread use in controlling quality of meal and mixed feeds containing cottonseed meal.

Another development is the use of microorganisms in determining nutritive value. We have established that the alignment of commercial cottonseed meals in terms of their nutritive qualities is the same for the protozoa *Tetrahymena pyriformins* as for chicks. Nutritive value of cottonseed meals can be established in four days with milligram quantities of meal by this means. Feeding tests with small laboratory animals are more expensive, require more time, and larger quantities of meal. Therefore, we believe that this information also can be very useful.

In discussing research developments, I have given more time and emphasis to projects which are not scheduled on the program for discussion in detail. Further details, of course, may be obtained during the conference and your visit in New Orleans.

During the tour at the close of the formal sessions you will have an opportunity to visit the pilot plant and various laboratories, and discuss any special problems with our research workers. As always, we shall be glad to give you any assistance we can, and will be most happy to hear your views about research in progress and research that you think is needed.

Welcome again, and best wishes for a most profitable and interesting conference.

RESPONSE

R. F. Patterson, Chairman
Research Committee
Mississippi Valley Oilseed Processors' Association, Inc.
Trenton, Tennessee

Thank you, Dr. Fisher. It is again my pleasure to speak for this group in thanking you for such a warm welcome and the comprehensive review of the work conducted at the Southern Laboratory. I can assure you that we're glad to be here. The presence of such a large group here this morning expresses more adequately than I could the appreciation we feel for you and your staff, and the importance we attach to these meetings. Your interest in our problems has resulted in great benefit to us and we look forward to a continued relationship with this Laboratory.

First Session

NEED FOR RESEARCH IN COTTONSEED PROCESSING

G. Harper, Director
National Cottonseed Products Association, Inc.
Dallas, Texas

There appears to be little need here to dwell on the already established fact that needed, well-planned, and aggressively pursued research is a productive economic tool. Perhaps we need to be more concerned with the realization that good research can be an antagonist rather than a benefactor. If our competitors employ productive research while we do little or nothing, we may lose in somewhat the same proportion as they gain. We can surely become the victim of the cold, ruthless advance of scientific achievement.

We shall understand why processing research must be such an important part of any research program of this Industry if we are able to dispel from our minds any conception that successful research is sheer magic. We cannot afford the luxury of believing that research, of its own inherent force and without our strenuous efforts and guidance, will lift us to a high economic plane. Just as scientific research is inescapably bound to the cold realism of facts, research opportunities and the application of successful research are controlled by facts. Mentally and economically, research is a costly, backbreaking pick-and-shovel operation. We must know what we are digging for and where it is most likely to be found before streaming perspiration and blistered hands dampen our enthusiasm and tarnish the superficial glamour.

Undoubtedly, there still exist good opportunities for important gains through investigations which substantiate our faith in the excellent worth of the products we now produce and for finding new uses for them. However, it would now appear that our principal gains will come through improvement of these products. If this be true, processing research is unsurpassed in importance. The only logical way to produce better products is to obtain accurate knowledge of what occurs to each important compound of the seed during processing and to find practical ways to prevent or increase this reaction as the need may be.

Since research is simply a search for facts, sound decisions on whether to engage in processing research must be founded first on one or both answers to a compound question. Are you producing the best products which can be made practically from the cottonseed and is your processing as efficient and economical as it can be? If the Industry cannot answer "yes" to each part of this question, there is an opportunity for good processing research to improve its competitive position.

Very few mill operators would claim to be chemists. Yet, each person who processes cottonseed is dealing directly with chemistry. From the time the cottonseed is purchased until the products are shipped chemical reactions are occurring. These chemical reac-

tions are especially rapid during the actual processing of the seed. Only through basic research can we learn the nature of these reactions and their degree of importance to practical crushing operations. Only through processing research can we hope to develop practical, profit-making procedures which will control detrimental reactions and promote helpful reactions. Dr. A. M. Altschul has said that in the past cottonseed processors have been the victims of chemical reactions which occur in processing and that they will be making technical progress only when they learn to become the masters of them. Such is the hard core of the research problems and opportunities which face us.

We need devote little time here to discussion of processing efficiency and economy. I doubt that any of you would have bothered to come to this Clinic during the nine years it has been held if you believed your mill were producing as efficiently and economically as you should like. While there may be no question as to need for greater efficiency and economy, there is much need to select with extreme care the areas which are most promising. Your discussions at these clinics are helping to guide the selection of the most promising areas of work. May I suggest here that we not be afraid to study drastic, radical-appearing ideas. Changes which are adopted in the mill must be practical, but sometimes a "wild-eyed" idea has a sneaky way of developing into practical application. Traditions are a grand part of any group's heritage as long as they do not become bonds and blinders.

In the field of cottonseed product quality, we should consider first any major opportunities which may exist for improvement of oil since it contributes the largest share of the total product revenue. Later in this program, authorities on cottonseed oil will report how many cottonseed oils become so highly colored that refining and bleaching by present methods will not reduce the color sufficiently to permit their use without blending with less colored oils. You, as an individual processor, may or may not have consistent difficulty with oil color. Yet, because of this difficulty, you are suffering lost income and profits since each time a deficiency in cottonseed oil causes the increased use of a competing oil, cottonseed oil is losing in competitive position. High oil color lends itself to research study. The pure triglycerides of which oil is composed are without color. Therefore, the color which appears in the oil is caused by seed pigments which are removed with the oil or by the reaction of other compounds with components of the oil to form a pigment. It follows that basic pigment and oil chemistry studies and processing research provide an opportunity to remove oil without pigments or to remove pigments from the extracted oil. A practical solution to this difficult problem is essential to the continued leadership of cottonseed oil in the food market. If that solution does not become a reality before the soybean industry solves its flavor reversion problem, we must expect our product to become second to soybean oil in quality standards. I need not ask you if our Industry can afford such a position. Even now, we have lost too much too quickly.

The opportunities for improvement in cottonseed meal quality through the use of better processing techniques are tremendously exciting. No feed product of this type can realize its full potential in usefulness and resulting economic returns as long as it is subject to major use restrictions. As you know so well, the movement of cottonseed meal into consumer markets is, for all present practical considerations, limited to cattle and sheep rations. These rations are recognized by feeding authorities to be less critical for many quality evaluations than those fed nonruminants. Therefore, while cottonseed meal may be superior to many sources of dietary nitrogen, its use is being limited to a class of rations where almost any concentrate can be used with considerable success. Such classification shades cottonseed meal evaluation toward the low-quality proteins. Our concern here is not simply a matter of pride. Potential profits are drastically affected as long as cottonseed meal cannot stand face to face with other protein sources on an equal basis in the market place. It is true that we have seen cottonseed meal used in significant quantities in poultry feeds, but we must remember that this use existed only as long as soybean meal was selling at a considerable price differential. I believe this Industry is seeking equality in the market place—not just movement of cottonseed meal at a lower price when soybean meal is scarce. It is also true that we sometimes see cottonseed meal selling to cattle feeders at a price equal to or above soybean meal. Without more foun-

dation than established prestige we could not hope to see such a situation continue.

It is well to consider the predicted use of protein concentrates in poultry and swine rations in cotton-growing states during this year. Stated in terms of 41% protein equivalent and calculated on the basis of percentage of birds and animals in these states this use will be:

Swine	1,007,000 tons
Laying hens	769,000 tons
Commercial broilers	1,735,000 tons
Other chickens	253,000 tons
Turkeys	458,000 tons
Total	4,222,000 tons

This is a market potential which is nearly double the present annual production of cottonseed meal. It is a worthy opportunity. Let me remind you that it is more than opportunity because when you fail to furnish this market, you are encouraging the demand for a competing oilseed which adds to your present burden of edible oil surplus. It is conceivable that the time may come when our Industry will be supplying this nonruminant market and encouraging the use of urea in ruminant feeds to fill the protein supply gap. If we were ready for such a situation now it would help solve two problems: (1) it would tend to reduce the pressure on increasing oil supplies resulting from protein demand, and (2) it would help prevent the increasing danger of widespread whole cottonseed feeding.

The need for processing research is evident because our present commercial cottonseed meals do not contain all the protein value which exists in the cottonseed protein. Figure I shows preliminary data from a test conducted by Barrick and Clawson at North Carolina State College. The test shows how a laboratory-prepared cottonseed meal compares with six commercial meals in rate of daily gain and gain produced per hundred pounds of ration consumed. Average daily gain rates provide an index to the productivity of the meals. Feed conversion or gain per hundred weight feed consumed determines how much the feeder can afford to pay for your meal. The laboratory-extracted meal, No. 106, undoubtedly is not the best meal which can be prepared from cottonseed but it is dramatically superior to the commercial meals tested. If the feeder pays $4.03, per 100 pounds, for a complete mixture containing this meal (as reported for average swine feed prices in **Agricultural Prices**, January 1960), he could afford to pay only $3.80 for a mixture containing the best commercial meal tested and $2.76 for a mixture containing the poorest commercial meal.

Since soybean meal is the major source of supplemental protein for swine, it is important to see how cottonseed meal compares with it. Figure II shows the average results of three tests. The cottonseed meal used was considered by available analytical tests to be a good-quality commercial cottonseed meal according to current commercial standards. It may be observed that cottonseed meal was equal to soybean meal when supplemental lysine was added to the ration. Also, mixtures of half soybean meal and half cottonseed meal were almost equal to soybean meal alone. The important point is that this cottonseed meal alone, promoted only about two-thirds of the gains obtained on soybean meal alone. Quite clearly, our processing must be improved so that commercial meals will be equal to or better than the laboratory-prepared meal discussed earlier if we are to become a significant factor in the swine feed market.

The conditions defined here for swine feeding with cottonseed meal generally are duplicated in broiler and growing turkey feeding.

A major opportunity for expanded cottonseed meal use is found in the rations of laying hens even though less may now be fed in these rations than in any others. Even small amounts of cottonseed meal may cause a dark discoloration of yolks in eggs stored for three to six months. (Photograph shown.) Apparently, the processing problem here is to eliminate gossypol and certain gossypol reaction products which cause the discoloration when significant changes occur in the pH of the eggs during storage. Also a pink discoloration of the egg white occurs during storage as a result of a fraction of the cottonseed oil. It has been believed by some that this problem is not of considerable practical importance because less and less fat is being left in the meal in modern solvent extraction. Some data recently obtained by Frampton, Piccolo, and Heywang indicate that this viewpoint may have been too optimistic. Figure III shows the incidence of pink discoloration in eggs stored for six months when the fat content of the meals used varied

from 5.66% to .46%. These workers reported the correlation between the percentage of pink whites and oil contents of the meal was not statistically significant. However, the curves shown in Figure III would suggest a rather good correlation when the meals are separated according to type of processing. These data appear to indicate that prepress solvent extraction, while reducing the fat content of the meal, may leave a higher proportion of the pink white factor in the meal on the basis of the total amount of fat in the meal. Regardless of the relationship which may exist there, it is important to note that even when the fat content of the meal was less than one-half of one percent, forty percent of the eggs developed pink discoloration during six months of storage. These meals were fed at a level of twenty percent of the total ration, replacing eighty percent of the soybean meal which was used in the control rations.

There may be more need to improve the quality of cottonseed meal protein for cattle and sheep than we have believd in the past. Figure IV shows results obtained by Tillman of Oklahoma in a series of protein digestibility trials. This work provides a strong suggestion that reactions between gossypol and protein under cooking conditions may reduce the availability of the protein for ruminants as well as for poultry and swine. Therefore, we may find it necessary to improve the protein quality of cottonseed meal during processing to maintain our leadership in the cattle feed market.

FIGURE I

9-WEEK PIG FEEDING TEST RESULTS

Preliminary - Not for Publication
(Clawson and Barrick, North Carolina State College)

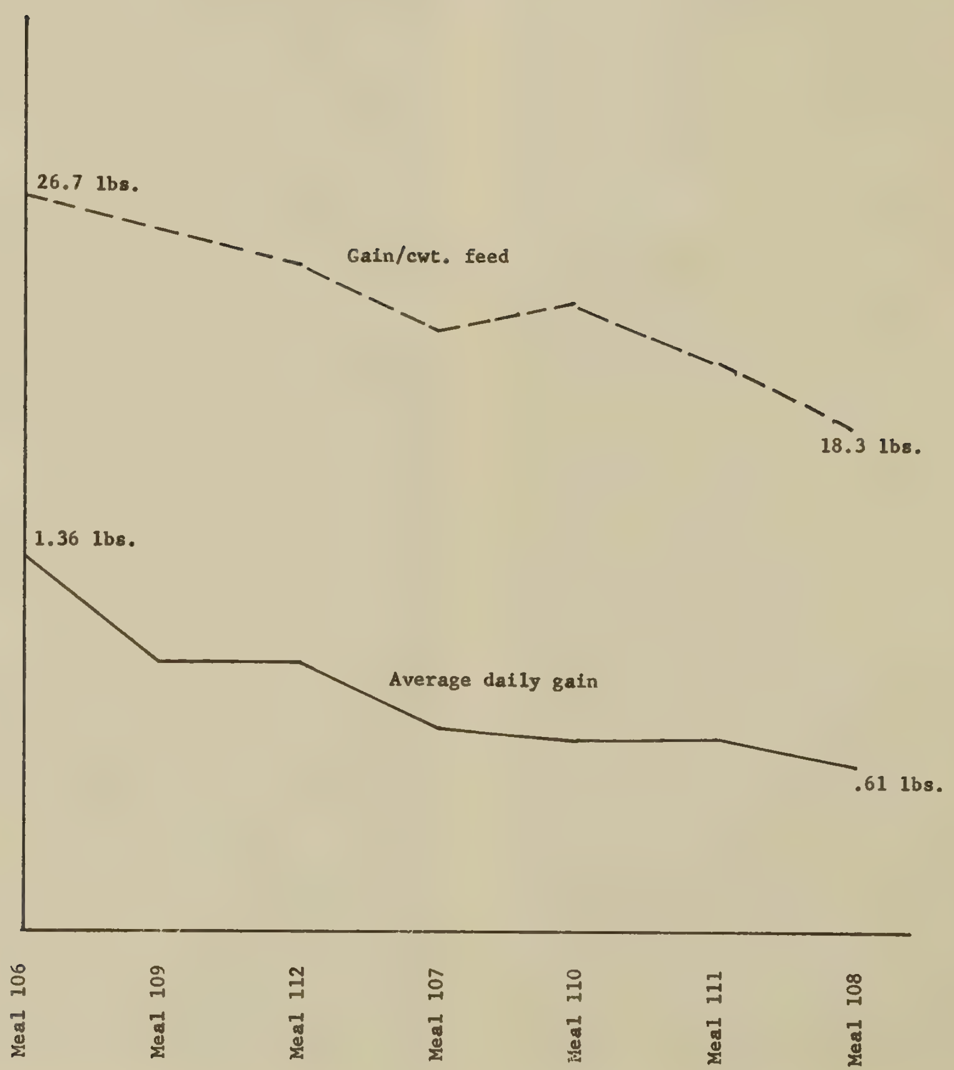


FIGURE II

COMPARISONS OF COMMERCIAL COTTONSEED MEAL AND SOYBEAN MEAL
AT THREE STATIONS

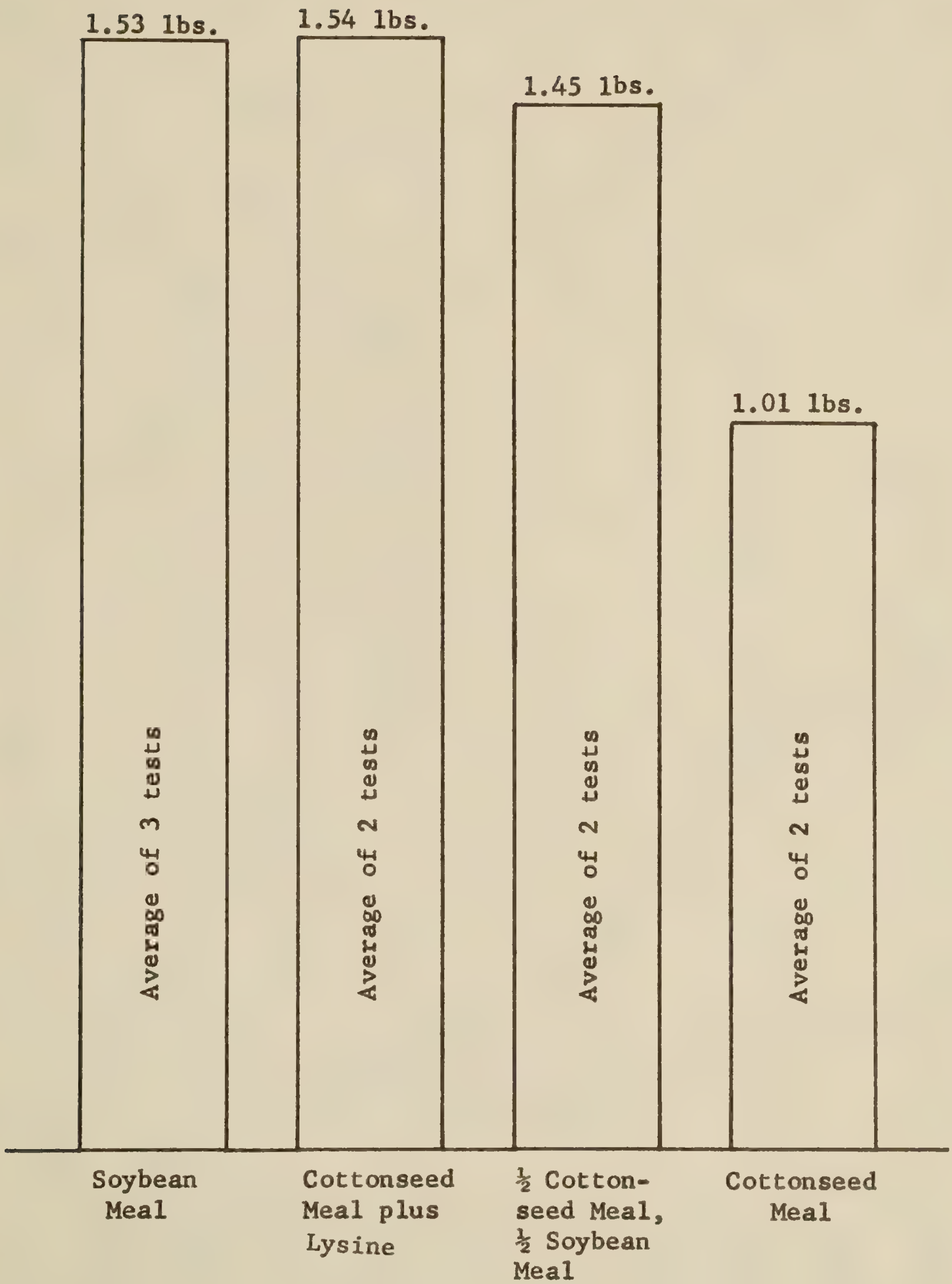


FIGURE III

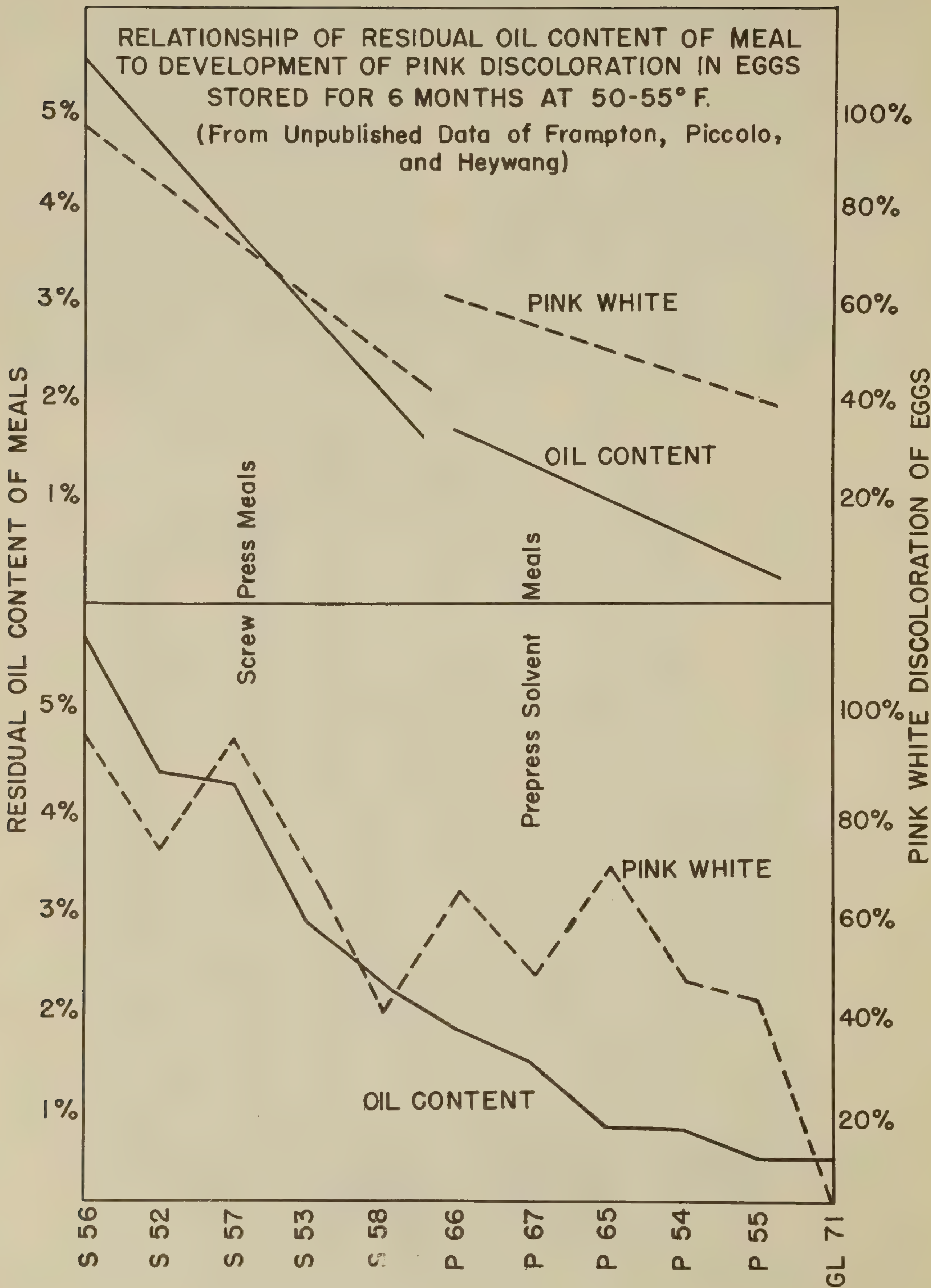
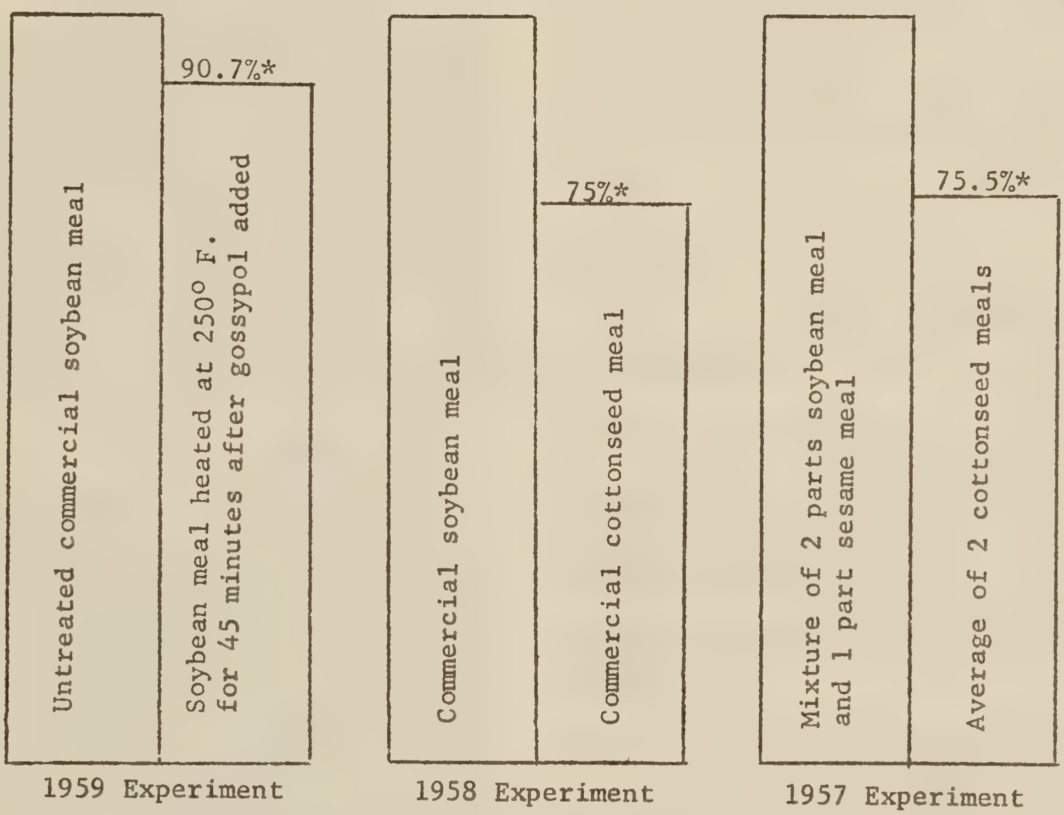

RELATIONSHIP OF RESIDUAL OIL CONTENT OF MEAL TO DEVELOPMENT OF PINK DISCOLORATION IN EGGS STORED FOR 6 MONTHS AT 50-55° F.
(From Unpublished Data of Frampton, Piccolo, and Heywang)
RESIDUAL OIL CONTENT OF MEALS
PINK WHITE DISCOLORATION OF EGGS
5%
4%
3%
2%
1%
100%
80%
60%
40%
20%
PINK WHITE
OIL CONTENT
Screw Press Meals
Prepress Solvent Meals
S 56
S 52
S 57
S 53
S 58
P 66
P 67
P 65
P 54
P 55
GL 71

FIGURE IV

PROTEIN DIGESTIBILITY BY RUMINANTS

(From data obtained by Tillman, Oklahoma)



* Values expressed as percentage of soybean control.

HOW TO COOK COTTONSEED MEATS FOR BEST RESULTS

H. D. Fincher
Anderson Clayton & Company
Houston, Texas

Introduction

It was with some reluctance that this assignment was accepted. The reluctance on my part being due to the fact that the cooking of cottonseed meats, like some of the other steps in processing cottonseed, has become a rather well-worn subject.

We have no magic formula to offer nor do we have anything particularly new or novel. We can only discuss with you the conditions which seem best suited for accomplishing the objectives we have in mind. Some of these objectives change as we shift from one extraction method to another. In establishing cooking conditions for reaching these objectives, the variables we have at our command are time, temperature, and moisture content.

Cooking, as we normally think of it, really consists of two steps. The first step is the actual cooking operation and the second is a drying operation.

Objectives

Alderks (1) has given the following reasons for cooking cottonseed meats:

1. To rupture or finish the rupturing of oil cells.
2. To increase the fluidity of the oil by increase in temperature.
3. To coagulate or granulate the protein aleurone grains. This facilitates a separation of the oil from the proteinaceous and other materials.
4. To "precipitate" phosphatidic material in order to produce oil of lower refining loss.
5. To dry the cooked meats mass to a proper moisture content, optimum for cake compression in the hydraulic press and for oil expression. This prevents "crawling" of wet meats (which is destructive to press cloths), or "crumbling" of dry meats.
6. To detoxify free gossypol by causing this material to diffuse from the resin glands and combine with proteinaceous material to form inert, nontoxic "bound" gossypol.
7. To destroy molds and bacteria.

To the above we might add one more:

8. To produce oil of better color by minimizing the amount of pigments extracted with the oil.

Having enumerated the reasons for cooking, we will mention here two general objectives which should be kept in mind in selecting our cooking conditions:

1. We should endeavor to keep heat damage to protein at a minimum.
2. We should try to suppress the development of phosphatidic material of the type not precipitated by water and which increases refining losses due to its emulsifying powers.

When we view the number of things we are trying to accomplish by cooking, we immediately realize that it would be a remarkable coincidence if any one set of conditions proved optimum for all of them. We all know that this coincidence does not exist and that conditions favorable to some objectives are unfavorable to others. Therefore, our cooking conditions must be a compromise as we approach, as near as possible, the accomplishment of all these objectives.

Hydraulic Cooking

The stack cooker has become the standard for hydraulic cooking in this country. We will mention batch cooking and continuous cooking without any description since all of you are familiar with these two general methods. In the opinion of the writer, batch cooking is slightly superior from the standpoint of extraction and oil quality. However, it is our belief that these advantages are more than offset by the ease of control and the greater flexibility of continuous cooking.

Since moisture plays a vital role in cooking, it is difficult to avoid some discussion of the humidification step. Where seed moistures are extremely low, some processors humidify delinted seed. We believe this to be an excellent practice but a holding time of up to 48 hours is required for penetration and reasonably uniform distribution of moisture in the meats.

If the moisture content of meats is below the desired level humidification can be accomplished with cold water before and/or after the rolls or with hot water or steam in the top kettle. The use of hot water or steam is not recommended for humidification of meats before they reach the top kettle of the cooker. Some operators will take issue on this point since they like to humidify unrolled meats with steam and water in a vesel such as the Anderson 36" horizontal cooker. This procedure certainly improves rolling where seed are unusually dry but the writer believes a better solution is additional rolling capacity. The reason for this will be apparent as we get into a discussion of temperature control in cooking.

For the best compromise on oil yield, oil quality and protein quality, the moisture content of meats in the top kettle should not be lower than 11% and preferably near 13%. It is desirable that the moisture be held in the meats during the entire period of cooking. Moisture retention during the cooking cycle contributes to better extraction, lower oil color and lower refining loss. Drying conditions should be adjusted to produce 5-6% moisture in former cake. This results in a finished cake containing 6.5-8.0% moisture.

In a stack cooker there is no sharp separation of the cooking and drying operations. However, we can make a rough division by saying that most of the cooking is done in the top three kettles and most of the drying occurs in the bottom two kettles of a 5-high cooker.

With reference to cooking temperatures, we like to reach 190°F. in the top kettle. It is desirable that the meats be brought up to this temperature as quickly as possible Live steam in the top kettle has the advantages of utilizing the heat of condensation for fast heating and at the same time accomplishing some humidification. Introduction of live steam through perforated pipes improves distribution. Rapid heating to 190°F. suppresses development of the type phosphatide that is not precipitated by water. This material is a good emulsifying agent and, if present in the oil, contributes to higher refining losses.

I would like to digress here for just a moment to say that this type of phosphatide can and does appear before the cooking operation. This undesirable material develops when we store hulled meats or rolled meats. The degree of development depends on storage time, temperature and moisture content. Once the damage is done it cannot be corrected in the cooking operation. This is a good reason for keeping meats overflow piles at a minimum and feeding them up at frequent intervals.

Relatively low top kettle temperatures, in the range 150-170°F., will produce slightly higher crude oil yields (1). However, the oil is of poorer quality and in most instances the yield of **refined** oil will be lower with these lower top kettle temperatures. Temperatures above 200°F. in the top kettle seem to have a detrimental effect on extraction. This may be due to the fact that our cookers are not tight enough to hold the optimum cooking moisture at these higher temperatures.

As the meats pass to the lower kettles the temperature is increased and should be 215-220°F. in the third kettle of a 5-high cooker. We may consider that most of the cooking is obtained at temperatures up to 220°F. Drying is accomplished by a further temperature increase in the lower kettles. The drying or finishing temperature normally should be 10-20°F. above the maximum cooking temperature.

We strongly recommend automatic control of temperature on the several kettles. On the top kettle, some operators prefer automatic control on the jacket steam, some prefer automatic control on live steam and others prefer the controller on both. My own preference is for a pressure reducing valve on jacket steam so set that it will not quite maintain 190°F. and with the controller on live steam which maintains the temperature at 190°F. This results in some flexibility and allows the operator to adjust the amount of humidification contributed by live steam when there are changes in moisture content of meats entering the cooker.

The question arises as to whether or not plows should be used on cooker sweeps. We believe plows are helpful. We are striving for uniformity in cooking and certainly good agitation contributes to this. Thorough agitation is, also, beneficial in the drying operation. One word of warning on the installation of plows, be careful not to overload the cooker motor.

We believe the optimum time for cooking and drying will fall within the range of 60 to 90 minutes. The operator has some latitude here and should resort to variations when the overall performance can be improved.

As mentioned before, our cooking conditions must be established on basis of a number of compromises. For protein quality alone, we would prefer much less drastic conditions. However, we must sacrifice some in protein quality to reach an acceptable level of free gossypol in meal and in order to obtain reasonable oil yields and oil quality.

We would like to point out that we are trying to outline average conditions for prime seed. Minor variations, too numerous to mention, will be made due to operator choice, seed quality, type of equipment, etc. In general, with off quality seed, products will be improved with less drastic cooking.

Cooking For Expellers Or Screw Presses

Some years ago when machines processed the meats from about 20 tons of cottonseed in 24 hours, we were not too much concerned with cooking capacity. It is true that a reasonable amount of cooking was necessary for oil quality. However, extraction and tonnage seemed to suffer very little even if we processed unrolled meats where we know a uniform cook was not obtained. This condition does not exist today with high speed presses handling the meats from 35 to 50 tons of seed in 24 hours. The merits of adequate cooking have been discussed by Vesey (2) and it was shown that extraction, tonnage and oil quality suffered when cooking capacity was inadequate. In cooking for continuous presses, Bredeson (3) has rated the capacity of a 72″ cooker at 7 tons/ring/24 hours, an 85″ cooker at 13 tons/ring/24 hours and a 100″ cooker at 20-22 tons/ring/24 hours.

We are not sure why additional cooking is required with high speed machines. Perhaps when operating at the lower throughput rates there is time for frictional heat to accomplish some cooking and coagulation of protein within the barrel of the press.

In cooking for continuous presses our objectives are essentially the same as those for hydraulic cooking. With respect to cooking alone, we believe optimum conditions are identical to those for hydraulic cooking.

To prevent crawling under the tremendous pressures developed, we must dry to a lower moisture content than for hydraulic. The drying time is kept within practical limits by increasing the temperature and by carrying a shallow bed of meats (as low as 7-½-8″) in the lower kettles. Experience has shown that extraction usually suffers when the moisture content of meats entering the press is allowed to go above 2.5-3.0%.

Again, there is no sharp separation between drying and cooking, but as practiced, cooking and drying temperatures are 20 to 40°F. higher than for hydraulic.

The higher processing temperatures and the frictional heat developed in the press are damaging to protein and account for the relatively low protein solubility for most meals of this type. Therefore, it is important that temperatures be kept as low as consistent with good extraction.

In this brief discussion of cooking for continuous presses, we have assumed the use of stack cookers. Many processors who originally had 36″ horizontal cookers have replaced or supplemented them with stack cookers. It is true that cooking can be done in the 36″ vessel but we believe the stack cooker provides a more uniform cook and better control of the operation.

Cooking for Prepress-Solvent Extraction

Cooking conditions for prepress-solvent extraction are less drastic than those for other extraction processes in general use today. This mild cooking is largely responsible for the relatively high protein solubility produced by this method. Some will say that heat and moisture treatment prior to direct solvent extraction is still less severe. We agree, but we would classify this as a conditioning operation rather than cooking.

Equipment for cooking is quite varied in the industry and the writer has seen installations of the following types:

1. 36″ horizontal cookers followed by 14″ conditioners.
2. Stacked 36″ horizontal cookers followed by 14″ conditioners.
3. Stack cookers followed by 36″ horizontal cookers and 14″ conditioners.
4. Stack cookers followed by 14″ conditioners.
5. Stack cookers alone.

Regardless of the type of equipment, it is recommended that live steam be used in the primary cooking vessel and that the temperature of the meats be brought to 180-190°F. as quickly as possible. The desired degree of

cooking can be accomplished at temperatures no higher than 210°F. and drying temperatures of 220-235°F. will suffice.

A moisture content of 14% during cooking gives good results. As in other cooking operations, it is desirable to hold this moisture during the cooking cycle and then reduce it rapidly during the drying cycle. It is only necessary to reduce the moisture in material entering the presses to 6-7%. This gives a moisture content of 9-10% in the prepressed cake.

A method of checking cooking conditions, which I believe was introduced by Dr. John W. Dunning of V. D. Anderson Co., consists of taking a sample of meats from the early part of the cooking cycle (such as, from the second kettle of a 5-high cooker). The meats are squeezed in the hand and if oil flows freely it can be assumed that moisture and temperature are properly adjusted.

The total time for cooking and drying will vary with equipment used but should be in the range of 20-45 minutes. The type of preparation used on cake for solvent extraction, also, influences the amount of cooking. Those who flake the material use less cooking to produce a rubbery cake which would be considered slightly green and raw by hydraulic standards but which produces a tough flake. Those who granulate for solvent extraction can stand slightly more cooking.

Cooking or Filtration-Extraction

Filtration-extraction is being used commercially and a number of papers have been published on this process (4-6).

The cooking operation is relatively mild and is similar to that for prepress-solvent extraction. However, the cooking is a little more thorough in the case of filtration-extraction.

Publications by Mr. Gastrock and his coworkers, who developed the process, indicate that the moisture content during cooking should be in the range of 12 to 20%. In commercial operation the moisture is probably in the range of 13 to 16%. Optimum moisture for extraction is given as 9% and, since there is a loss of about 2% in the atmospheric cooling and crisping operation, meats would discharge from the cooker at a moisture content near 11%.

A top ring temperature of 200-210°F. is recommended and the cooking is carried out at a temperature of 210-215°F. Drying is accomplished at 220-225°F., higher temperatures not being required because the meats discharge at a relatively high moisture content.

The total time for cooking and drying is in the range of 40-75 minutes. This is slightly less than that for hydraulic or screw press but is somewhat longer than for prepress-solvent extraction.

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INVESTIGATION OF CHANGES IN THE NUTRITIVE QUALITY OF COTTONSEED MEAL DURING PROCESSING. RELATIVE EFFECT OF GOSSYPOL AND CARBOHYDRATES

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Recent work has established that there is an impairment in the nutritive quality of cottonseed meal when it is subjected to heat treatment. A part of the impairment is due to the destruction of a portion of the lysine in the proteins. The mechanism of this destruction

is not known. It is possible that both carbohydrates and gossypol are involved, since amino acids are deaminated and decarboxylated when heated in the presence of either of these two carbonyl or potential carbonyl containing substances.

A part of the impairment of the nutritive quality may also be due to the unavailability of lysine in the meal to the animal because of the reaction **in situ** of gossypol, sugar, or other constituents, with the free epsilon groups of lysine in the proteins.

A study of the relative importance of raffinose and gossypol in (a) the destruction of lysine, (b) the binding of the epsilon amino group of lysine and, (c) the impairment of the nutritive quality of cottonseed meal was made possible through the use of gossypol-free cottonseed made available by the U. S. Cotton Field Station, Shafter, California, which served as a source of cottonseed proteins that had not been exposed to reaction with gossypol.

Glandless cottonseed was dehulled, flaked, and extracted with hexane. The resulting meal was permitted to dry at room temperature, and most of the hull fragments retained in the dried meal were removed on a 30 mesh screen. The stock supply of cottonseed meal prepared in this manner was designated as CM-71.

Portions of meal CM-71, 225 g. each, were extracted successively with 20 one-liter quantities of 80% aqueous ethyl alcohol, followed by 3 one-liter quantities of diethyl ether, to remove sugars and phosphatide materials. The several lots of alcohol- and ether-extracted meal were desolventized at room temperature, combined, and thoroughly mixed. The stock meal prepared in this manner was designated as CM-71-A.

The other meals used in this study were prepared from the two stocks of meals described above.

CM-71-AR was prepared by adding 10% by weight of twice crystallized raffinose hydrate to CM-71-A. The mixture was then ground in a ball mill for 1 hour for complete mixing.

CM-71-AG was prepared by adding 1% gossypol in acetone solution to CM-71-A. Sufficient acetone was added to the mixture to form a slurry. This was mixed thoroughly and then the acetone was permitted to evaporate at room temperature. The dry residue was then ground in a ball mill for 1 hour.

CM-71-AGR was prepared by adding both raffinose and gossypol to CM-71-A. Raffinose was added first in the manner indicated above for CM-71-AR, and this was followed by the addition of gossypol, in the manner indicated for CM-71-AG.

CM-71-AS was the residue obtained when CM-71-A was extracted with 1.5 M NaCl in 50% aqueous ethanol. Ten grams of CM-71-A were suspended in 100 milliliters of the salt solution in a 250 ml. bottle and shaken mechanically for 1 hour. The mixture was then centrifuged and the supernatant liquid was decanted. The residue was extracted a second time in the same manner. The residue remaining after the second extraction was suspended in water and dialyzed against running distilled water at 5° for 72 hours. The material was then frozen and lyophylized.

Appropriate quantities of each meal preparation were heated at 121°C. for 20 and 60 minutes in a steam jacketed autoclave. All meals to which gossypol was added were extracted, subsequent to heating for 0, 20, and 60 minutes, with diethyl ether for 16 hours in a Soxhlet extraction apparatus to remove free gossypol.

The first three liters of the 80% alcohol extract of each portion of CM-71 were combined and dialyzed against distilled water at 5° C. for 72 hours. The dialyzate was concentrated under vacuum to a minimum volume for paper chromatographic analysis. The inner liquor or dialyzed material was frozen and lyophylized for identification.

The alcohol-salt extracts isolated during the preparation of CM-71-AS were combined and dialyzed against 0.01 M acetic acid at 5°C. for 72 hours with three changes of acid. The non-dialyzable material was frozen and lyophylized for analysis.

Total nitrogen, free gossypol and moisture were determined for the several meal preparations by the official methods of the American Oil Chemists' Society. Total gossypol was determined by the method of Pons, Pittman and Hoffpauir. Determinations of phosphorous derivatives were by the method of Pons, Stansbury and Hoffpauir. Nitrogen solubility was determined by the method of Lyman, **et al.** Total and reducing sugars were determined ac-

cording to methods described by the methods of the Association of Official Agricultural Chemists. The basic amino acids were determined by the method of Moore and Stein with a modification in the sample preparation and column size. The free epsilon amino groups of lysine in the meal proteins were determined by the method described by Conkerton and Frampton.

The nutritive indices (ratio of the average weight gained by rats on experimental meal to the average weight gained on a reference protein,) were determined by the Cabell and Earle modification of the Cannon rat repletion method. Eight rats were used for each meal preparation.

Although CM-71-AG, CM-71-AG-20, CM-71-AG-60, CM-71-ARG-20 and CM-71-ARG-60 were exhaustively extracted with diethyl ether, analyses for free gossypol by the AOAC method indicated the presence of free gossypol. It is probable that the data for free gossypol recorded in Table I represent gossypol derivatives that are soluble in aqueous acetone and are converted to dianilinogossypol in the analytical determination.

The percent total or bound gossypol increased with autoclaving; however, the presence of carbohydrate decreased the percent bound in the meal.

Table I.—*Properties of Glandless Cottonseed Meal and Meal Fractions*

Sample	Time heated	Nutritive index	Lysine g./16 g.N DNFB	Lysine Ion exchange	Lysine Bound	Arginine Ion exchange g./16 g.N	Nitrogen percent Total	Nitrogen percent Soluble	Gossypol percent Free	Gossypol percent Total	Sugars percent Reducing	Sugars percent Total
CM-71	0	101	4.1	4.2	0.1	11.4	8.5	97	0.00	0.00	0.37	10.39
	20	76	3.7	3.7	0.0	11.6	8.5	44	0.00	0.00	0.52	11.46
	60	68	3.1	3.5	0.4	10.2	8.6	29	0.00	0.00	0.62	10.49
CM-71-A	0	96	4.6	4.6	0.0	11.4	10.3	86	0.00	0.00	0.05	0.09
	20	101	4.3	4.3	0.1	11.3	10.4	42	0.00	0.00	0.02	0.06
	60	86	4.1	4.2	0.1	11.4	10.5	41	0.00	0.00	0.02	0.06
CM-71-AR	0	93	4.4	4.4	0.0	11.5	9.4	90	0.00	0.00	0.17	7.03
	20	86	4.2	4.3	0.1	11.5	9.6	45	0.00	0.00	0.21	7.05
	60	71	3.6	4.0	0.4	11.3	9.6	36	0.00	0.00	0.42	6.91
CM-71-AG	0	90	4.2	4.4	0.2	11.6	10.1	79	0.06	0.55	...	...
	20	75	3.9	4.4	0.5	11.6	10.3	39	0.02	0.84	...	...
	60	61	3.5	4.3	0.8	11.2	10.4	41	0.02	0.82	...	...
CM-71-ARG	20	85	4.1	4.2	0.1	11.1	9.5	46	0.03	0.63	0.23	7.33
	60	70	3.5	4.1	0.6	10.9	9.5	32	0.01	0.75	0.39	6.75
CM-71-AS	0	85	4.1	4.2	0.1	10.5	10.3	80	0.00	0.00	0.02	0.04
	20	85	4.1	4.2	0.1	10.5	10.3	45	0.00	0.00	0.02	0.15
	60	75	3.7	4.2	0.5	10.5	10.3	47	0.00	0.00	0.03	0.33

Twenty-one percent by weight of CM-71 was removed on extraction with 80% ethyl alcohol in the preparation of CM-71-A. This included 99% of the raffinose (11% of the meal) and 4% of the total nitrogen of the meal. Data recorded in Table II indicate that 96% of the phosphatide and 43% of the inorganic phosphorous were also removed. One and two dimensional paper chromatographic analyses of the concentrated dialyzate of the alcohol extract indicated the presence of at least 5 flavonoid-like pigments and 14 ninhydrinpositive components. No basic amino acids were noted on these chromatograms. The dialyzed material obtained on lyophylization was pale yellow in color and it browned rapidly on exposure to moisture and air. Qualitative tests indicated the presence of phosphatide.

The further extraction of the alcohol extracted-meal with the salt-alcohol solution removed 21% of the material by weight and 21% of the phosphorous, which included all of the nucleic acid phosphorus. Dialysis and lyophilization of the extract yielded a protein material which represented about half of the nitrogen and phosphorus content of the extract. This material on further purification yielded a protein containing 15% nitrogen, 2% sulfur, 0.1% phosphorus, and 0.25% ash. The protein also gave a strong Molish reaction.

Nutritive indices and chemical properties of the several meal preparations are recorded in Table I. Analyses of the data from the rat repletion experiments indicated odds of 20:1 that diferences between meals of more than 10% in the nutritive index are real.

Table II.—*Phosphorus Compounds in Glandless Cottonseed Meal and Meal Fractions*

Sample	Time heated	Moisture percent	Phosphorus, percent						
			Total	Phytin	Acid Soluble	Phosphatide	Inorganic	Nucleic	Ester type
CM-71	0	10.2	1.85	1.59	1.68	0.102	0.06	0.078	0.02
	20	10.3	1.81	1.51	1.76	0.080	0.02	0.000	0.05
	60	10.1	1.78	1.42	1.74	0.070	0.31	0.000	0.01
CM-71-A	0	13.5	2.15	1.96	2.06	0.004	0.08	0.096	0.06
	20	12.1	2.11	1.91	2.11	0.000	0.17	0.000	0.02
	60	11.8	2.13	1.83	2.16	0.000	0.32	0.000	0.00
CM-71-AR	0	13.4	1.91	1.71	1.88	0.000	0.04	0.030	0.13
	20	11.6	1.97	1.75	1.95	0.000	0.14	0.010	0.06
	60	11.5	1.97	1.63	1.96	0.000	0.35	0.020	0.00
CM-71-AG	0	12.7	2.07	1.80	2.00	0.000	0.05	0.070	0.13
	20	11.6	2.11	1.82	2.05	0.000	0.17	0.070	0.05
	60	11.5	2.14	1.82	2.10	0.000	0.34	0.040	0.00
CM-71-ARG	20	10.9	1.95	1.65	1.92	0.000	0.16	0.040	0.11
	60	11.2	1.94	1.68	1.94	0.000	0.28	0.000	0.00
CM-71-AS	0	10.9	2.13	1.92	2.14	0.002	0.03	0.000	0.19
	20	11.5	2.13	1.97	2.15	0.015	0.16	0.000	0.02
	60	11.2	2.13	1.97	2.16	0.016	0.28	0.000	0.00

Several significant relationships suggested by the data may be pointed out. Heating cottonseed meal (CM-71) in the total absence of gossypol caused a marked reduction in the nutritive value, even when the treatment was limited to 20 minutes. When the carbohydrates (and other alcohol soluble materials) were removed prior to autoclaving, a 60-minute autoclaving period yielded a product with a nutritive index significantly higher than was obtained on heating CM-71 for 20 minutes, while a 20-minute heating period for CM-71-A induced no impairment in nutritive value. Furthermore, a substantial part of the lysine in the meal proteins was bound and destroyed by heating CM-71, whereas neither binding nor destruction of lysine was extensive when raffinose and other soluble substances were removed (CM-71-A) prior to heating. It may be noted that neither the addition of raffinose or gossypol or both to CM-71-A caused as great a destruction of lysine when the meal was heated as that encountered with CM-71. Obviously this marked difference between CM-71 and CM-71-A in the quantity of lysine destroyed cannot all be attributed exclusively to the raffinose present in CM-71.

It is also noted that the reduction of the arginine content obtained on heating CM-71 was not noted in any of the other meals. The addition of raffinose or gossypol, or both, did not affect the arginine content. Apparently some alcohol soluble constituent present in CM-71 is responsible for the loss of arginine during heating.

The protein obtained after alcohol-salt extraction (CM-71-AS) showed no decrease in lysine content, as measured by the ion exchange procedure, and very little decrease as measured by the dinitrofluorobenzene (DNFB) method.

The greatest binding of lysine and the lowest nutritive index were obtained when CM-71-AG was heated. Raffinose, when added to CM-71-A, seemed to reduce the efects of gossypol, for, as may be noted from the data recorded in Table I, there was no greater lowering of the nutritive index on heating CM-71-ARG than that noted for CM-71-AR.

A correlation coefficient of 0.86 (with 16 degrees of freedom) was calculated from regression analysis of the lysine data obtained by the DNFB method and the nutritive index. The curve for the regression of the nutritive index on the lysine content of the meals, as determined by the method of Conkerton and Frampton is shown in Figure 1. The correlation between the nutritive index and the lysine content of the meals as determined by the method of Moore and Stein was 0.50. The lysine datum obtained by the DNFB method is interpreted here as the quantity of lysine in

the meal protein with the epsilon amino group free. The difference between this datum and the measure of lysine obtained by the ion exchange procedure apparently determines that portion of the lysine in the protein where the epsilon amino group is not free, but can be liberated on acid hydrolysis. This is referred to as bound lysine.

The implication from the two regression analyses is that protein depleted rats cannot utilize the lysine of the protein if the epsilon amino groups are not free. This view is supported by the results of a multiple regression analysis of the destroyed lysine and the bound lysine on the reduction in the nutritive index. The regression equation obtained from the analysis is

$$\underline{R} = 9.6 + 24.9\,\underline{d} + 15.1\,\underline{b}$$

where $\underline{R}$ is the reduction in the nutritive value obtained with the various treatments, $\underline{d}$ is the quantity of lysine destroyed and $\underline{b}$ is the quantity of lysine bound expressed as g./16g.N. The coefficient for $\underline{b}$ would be zero if the depleted rat utilized all of the bound lysine. The reduction in nutritive value in processed cottonseed is due, therefore, not only to lysine destruction but to lysine binding as well.

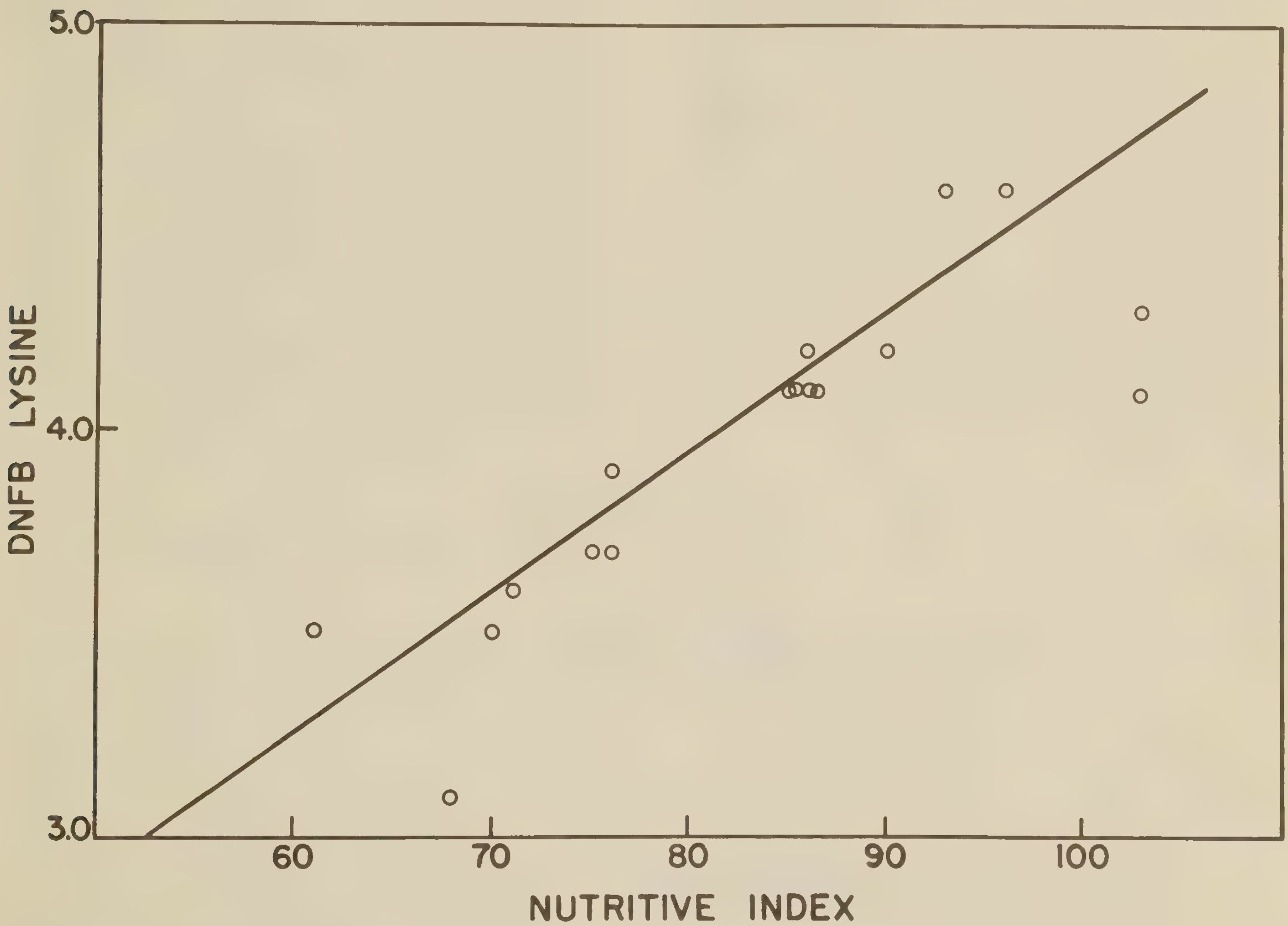

Figure 1. Regression of Nutritive Index on Lysine with Free Epsilon Amino Groups, g./16g. N.

PROTEIN QUALITY OF MEAL SHIPMENTS

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In an overall consideration of the total value realized from the products per ton of cottonseed, it is the oil product which is most important from an economic viewpoint. The lint is a less important factor because it furnishes a lower profit return. The meal fraction is one which is not given much consideration. Often, the average figures obtained for the ammonia content of a finished lot of meal are accepted by the mills as being representative of values for ammonia in each day's production of meal. Unless careful control is practiced in maintaining a uniform meal product, the mill can be losing part of its potential profits. We had an opportunity to examine several samples of meal from Texas; those meals showed a wide range in their ammonia contents. If the mill operator does not know the exact ammonia content of meal supplied to a buyer, the buyer may be receiving more protein than he purchased, representing a profit loss to the mill operator.

The ranges of ammonia contents for meals from Buckeye mills are illustrated in the charts I have distributed. (Charts inserted at conclusion of this report.) For each mill are shown the mean and standard deviation for ammonia contents. For example, in the third chart are shown the data for meals from mills K and L. The means obtained by statistical analysis of data from ammonia contents are of the same value, 8.03, for mills K and L. But the range in ammonia content of the meal from mill L is of a larger spread than that for mill K. The standard deviation for ammonia values from mill K was 0.06 while that for values from mill L was 0.10. In most cases for mills included in this study, a normal standard probability curve for ammonia content was not obtained. Instead, the probability curve was of the type that the axis tended to be shifted to the left and at a lower position. This showed only about sixty percent of the meal production was in one range. When the spread for the average meal ammonia values from a mill is wide, the customer certainly does not get meal of a certain protein content that he wanted and for which he paid. The purpose of better and efficient production is to get a narrower range for ammonia values.

In order to eliminate such a wide spread in ammonia values for meal from any one mill, it may be necessary to devise and install the proper equipment, provided that the money for such recommendations is available. If funds do not allow installation of new equipment, then the present equipment of that mill should be utilized fully to obtain a more uniform meal product. Uniformity of product should apply from bag to bag of meal as well as from stack to stack of meal. Supervision of details is one of the most important means for obtaining uniformity. It has been seen that a mill will install new equipment to make a uniform meal product, and, if the attention of the supervisory personnel is shifted to other matters, the meal produced at that time will show a wide spread in ammonia contents. If careful supervision is lacking at a mill having a volume of good equipment, the meal from that mill will not be of uniform quality. On the other hand, a mill with poor equipment but with careful attention to supervisory details will very likely produce a more uniform meal product. Remember if the buyer obtains more protein in meal than he wanted and for which he paid, you are giving away protein and losing part of your profit.

The factor of personal supervision is as important to making a uniform product of meal as the necessity for having the proper processing equipment. When the hands in charge of operations get busy with other details and pay less attention to making a uniform meal product, the uniformity of the meal usually decreases.

Successful blending of the cottonseed cake as well as that of the final meal product is similarly important for obtaining uniform composition of meal. Some of you may have tiered bins in your mills, but today most mills have large volume bins. The meal from each bin should be broken into small increments for analysis. It is necessary to know the composition of the meal in the bin so well in order to be able to know exactly how much of meal

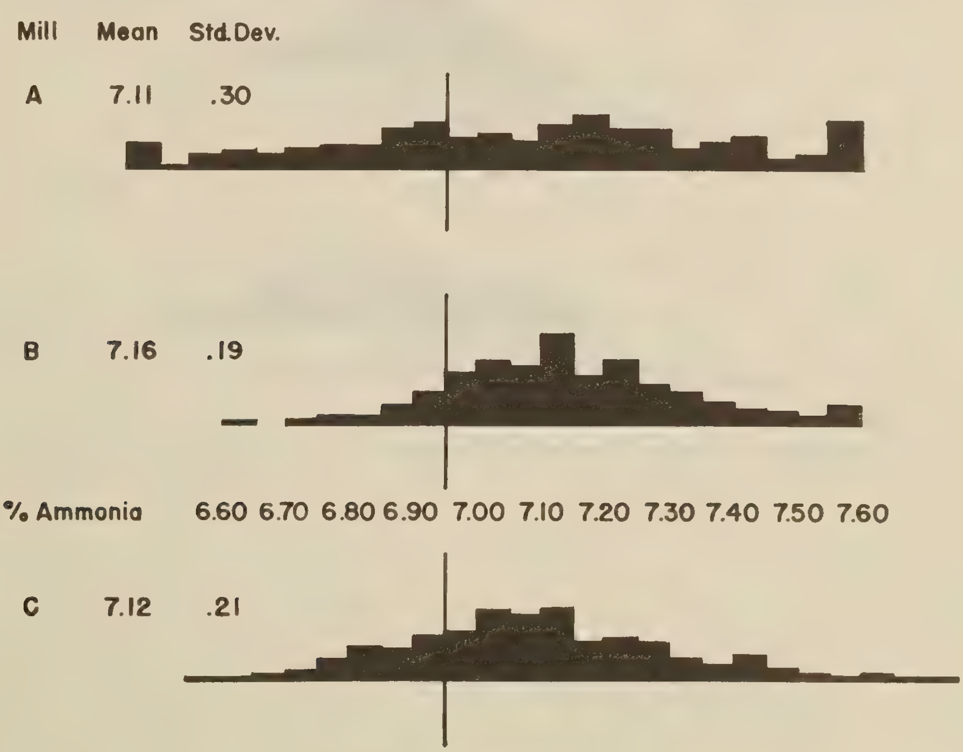
from one part of the bin can be mixed with that from another section of the bin to give a meal of a definite protein composition. Samples should be taken each day from the bins; a sample of 30 pounds at least is needed for analysis. A gross sample less than 30 pounds is too small for analytical determination. An automatic sample is recommended. After sampling, remove spout from the sampler and clean it. Aspiration control should be exerted so that no protein material of light size is obtained. Protect the cans containing samples. Make certain to blend the meal and the cake samples well before analyzing them. Run 2 samples simultaneously.

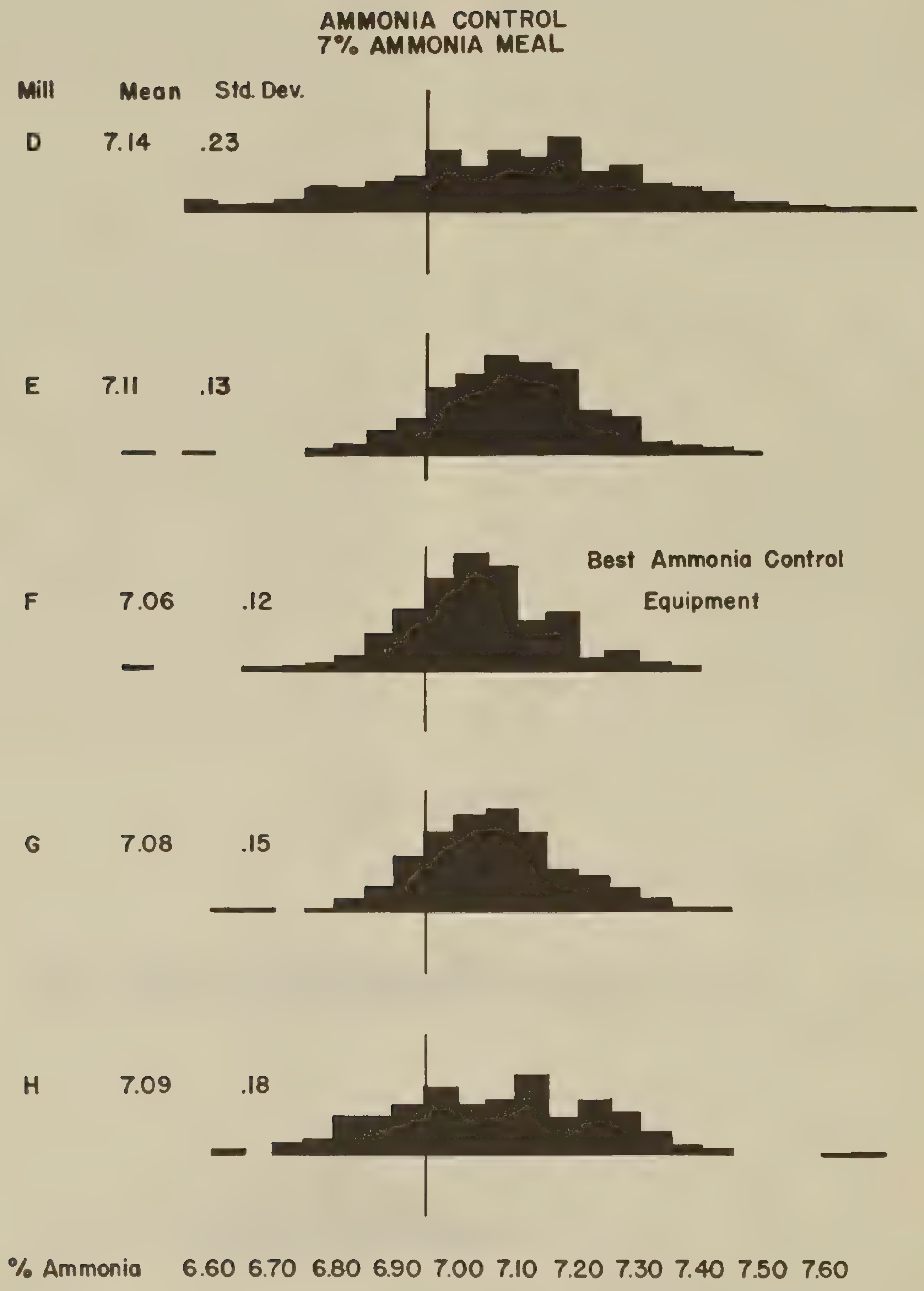
The matter of bran addition is another important step. Often times, when their supply of bran has been exhausted, some mills will not purchase bran. Those mills, lacking sufficient quantity of bran, are selling meal of higher protein content and are losing money. A good policy to be followed is: work the production of bran from one day's operation back into the cake produced that same day. Always remember to make careful samplings. An automatic sampling device is best. Although the grab technique could yield a representative sample, the nature of the grab sample depends strongly on the caliber of the person doing the sampling. It is recommended that you use the best equipment possible and establish the most efficient and best methods for producing a homogenized product of meal. The importance of blending cake and meal, as well as the importance of adding the correct amounts of bran cannot be overstressed. You might one day be selling a sack of bran to your buyer instead of a sack of meal. A loss of customer and a loss of profit should be avoided equally.

Check the accuracy of your equipment from time to time. Some modification of the equipment might be necessitated so that its accuracy can be checked more easily. The equipment should be maintained in good working condition to help maintain uniformity in production.

The last chart shows the economics of controlling ammonia content of meals. This control should not be left to chance. Discuss your results with your laboratory personnel. If your analysis is not correct, this and all other variables enhance the error in final calculations. Good personnel supervision, proper equipment and best processing methods—all will contribute to increasing uniformity. Giving more effort to gain better control of ammonia contents should lead to production of a uniform meal product and an increase in profits.

AMMONIA CONTROL
7% AMMONIA MEAL




AMMONIA CONTROL
7% AMMONIA MEAL
Mill
Mean
Std. Dev.
D
7.14
.23
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Best Ammonia Control
Equipment
F
7.06
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G
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H
7.09
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% Ammonia
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AMMONIA CONTROL
8% AMMONIA MEAL

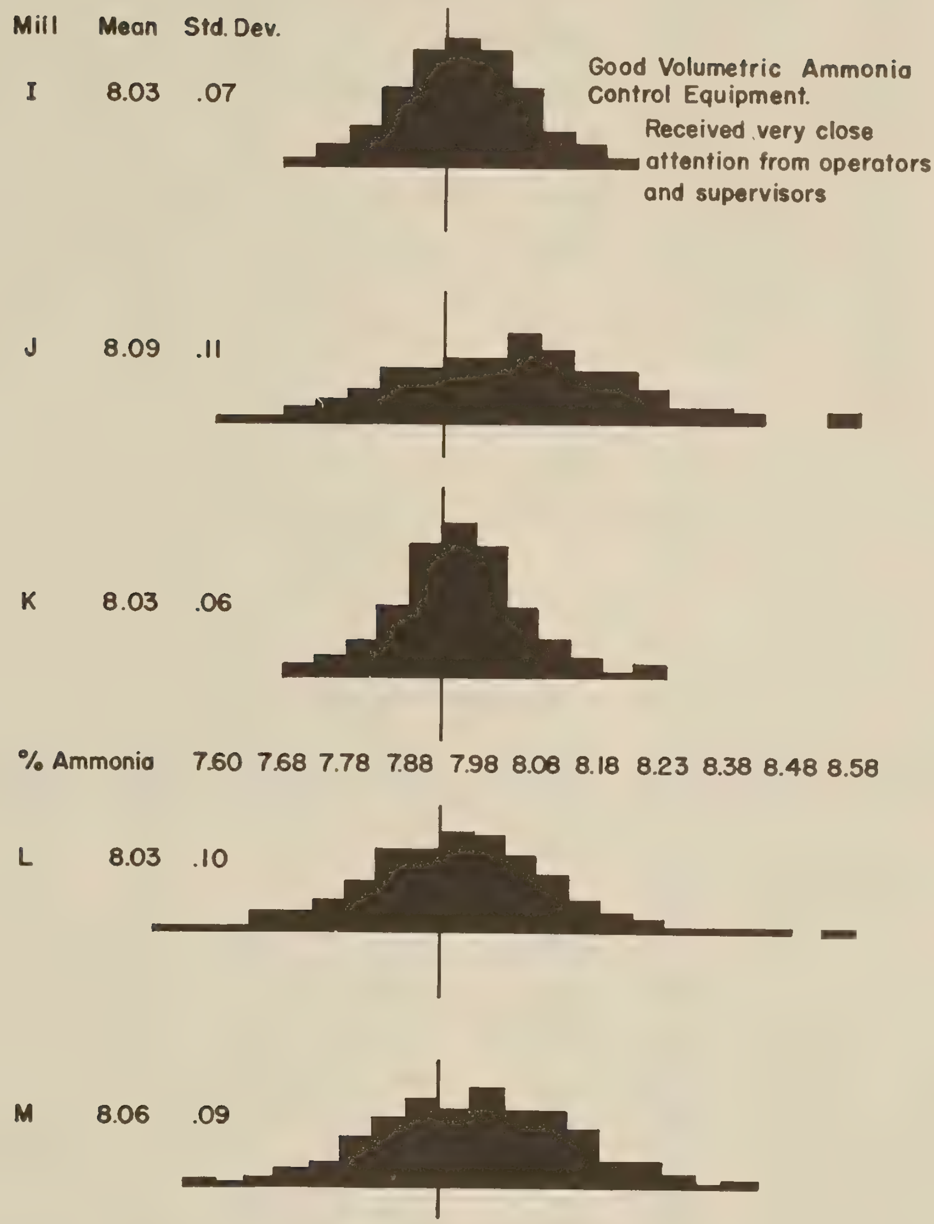

Table I.—*Ammonia Control Deviation from Mean*

Mill	1955-56 Mean	1955-56 Std. Deviation	1956-57 Mean	1956-57 Std. Deviation	1957-58 Mean	1957-58 Std. Deviation	1958-59 Mean	1958-59 Std. Deviation
A	7.14	.17	7.17	.19	7.13	.23	7.11	.30
B	7.11	.21	7.18	.25	7.16	.18	7.16	.19
C	7.06	.21	7.12	.19	7.09	.15	7.12	.21
D	7.09	.22	7.13	.23	7.12	.21	7.14	.23
E	7.11	.18	7.12	.16	7.10	.15	7.11	.13
F	7.08	.12	7.07	.10	7.06	.10	7.06	.12
G	7.21	.19	7.13	.16	7.12	.15	7.08	.15
H	7.02	.21	7.10	.25	7.09	.21	7.09	.18
I	8.03	.13	8.08	.18	8.09	.13	8.03	.07
J	8.00	.27	...	...	8.09	.18	8.09	.11
K	8.09	.15	8.08	.11	8.03	.13	8.03	.06
L	8.07	.20	8.03	.21	8.02	.16	8.03	.10
M	8.07	.15	8.08	.16	8.08	.13	8.06	.09

Table II.—*Economic Realization from Regrinding*

Mill	1000 Tons	Mean Meal NH_3	Std. Dev.	Total Meal Lbs/Ton Seed	Value of Excess NH_3 $/Ton Seed*	Theor. % Regrind. Actual NH_3	Theor. Cost/ Ton to Regrind Actual NH_3	% Regrind Reduced Avg. **	Regrind Cost $/Ton Seed**	Diff. Regrind Cost	Net Savings to Reduce Avg. NH_3 $/Ton Seed	Tons Actually Reground
A	7	7.11	.30	1068	$ .272	19.5	.208	26.4	$ .282	$ .074	$ .198	0
B	13	7.16	.19	1023	.446	5.2	.053	15.9	.163	.110	.336	0
C	8	7.12	.21	1073	.311	9.9	.106	18.1	.195	.089	.222	280
D	7	7.14	.23	947	.392	10.4	.099	20.3	.193	.094	.298	420
E	10	7.11	.13	1016	.259	2.3	.023	7.1	.072	.049	.210	135
F	8	7.06	.12	1052	.077	4.0	.042	5.6	.059	.017	.060	60
G	7	7.08	.15	1020	.222	6.3	.064	10.2	.104	.040	.182	113
H	3	7.09	.18	1011	.203	9.2	.093	14.5	.147	.054	.149	30
I	12	8.03	.07	900	.028	.3	.003	.3	.003	...	.028	15
J	19	8.09	.11	928	.201	.9	.008	4.2	.039	.031	.170	180
K	38	8.03	.06	880	.027	.05	...	.08	.001	.001	.026	261
L	24	8.03	.10	889	.027	2.3	.020	2.9	.026	.006	.021	535
M	17	8.06	.09	892	.111	.5	.004	1.7	.015	.011	.100	150

* At $60 meal and $10 bran—excess NH_3 over 8.02 or 7.04%

** Assuming average NH_3 reduced to 8.02 or 7.04%—Regrind only low meal at $2.00/ton meal.

Panel Discussion

Moderator: V. L. Frampton

Members: G. A. Harper, H. O. Fincher, W. G. Quinn

MacGee: In regard to feeding studies with soybean oil meal and cottonseed meal was any test made to determine relation between variability of meals and geographical source of the seed, e.g., meals from California compared with those from Atlantic Coast?

Harper: We know that variations exist among cottonseed meals. In the studies I mentioned, the meal used by one investigator was not always the meal used by other investigators. The work reported and shown in the first chart was done with 2 meals from West Texas; one meal was of high nitrogen solubility and the other of low nitrogen solubility. We picked meals with the definite characteristics that we wanted. No attempt was made to determine the relationship between the source of the cottonseed and the nutritional properties of meals produced from the seed.

Kidd: Do soybean oil meals vary in quality from section to section of the country?

Harper: Yes.

Quinn: Can you expect the differences in processing conditions to account for differences in meals as much as differences in geographical source? There is need for establishment of standard processing conditions to obtain a control meal.

Harper: We are determining the effects of processing conditions. For example, Tillman, in his experiments with soybean oil meal has tried to give the soybean oil meal the same treatment as the cottonseed meal. Of course, the soybean meal already had been subjected to commercial processing before he received it.

Frampton: Mr. Harper, you talked about the data in the lower part of your slide as showing some results obtained by B. Haywang in determining the factor responsible for the pink discolorations of egg whites. To what do the data in upper part of the slide refer?

Harper: Actually, the data in the upper part of that slide were prepared by Dr. Phelps for presentation at another meeting. He is not here at this moment to explain his calculations. The data at the bottom of the slide show correlations of calculations made from comparing the fat content of the meals with the amount of pink "whites" developed in the eggs.

Frampton: That cooperative study between Haywang and us was designed mainly to learn about the factor causing brown yolk discolorations. How does the work of Kemmerer on the factor causing pink "whites" fit in with correlations from Haywang's data?

Harper: Kemmerer and Evans studied the relationship between cottonseed oil fractions and the development of pink "whites." Correlations from Haywang's work fit in very well with the work done by Kemmerer and Evans.

Tenent: Is it possible to supplement cottonseed meals with lysine?

Frampton: Yes. Mr. Harper can give you some information about this.

Harper: Smith at North Carolina showed that supplementation of cottonseed meal with 0.25 percent lysine increased meal nutritive value. The lysine was a fermentaton product obtained from the Pfizer Company.

Tenent: Will supplementation with lysine raise the nutritive value of the meal for non-ruminants?

Harper: Yes. This type of study has been carried out, for example, by the Pfizer people, but the work can-

not be reported at the present time. More work has to be done before any recommendations can be made. Increasing meal nutritive value for swine and poultry with lysine supplementation is also being studied. The economics involved are an important part of this work. We expect the cost of lysine to decrease in a short period.

Kidd: If lysine supplementation proves practical, will the resulting product be considered a mixed feed or a cottonseed meal by Washington?

Harper: It will not make any difference whether the mill processor or the feed manufacturer adds the lysine. Lysine supplementation should be good in any case.

Kidd: Will lysine content have to be marked on meal sack tags?

Harper: Yes, I think it should be if our results warrant it.

Quinn: It will be necessary in order to let the feed manufacturer know the composition of the meal and how much lysine he might need to add.

Sylvester: Which meal is better for fattening cattle: solvent-extracted meal or hydraulic-presed meal.

Harper: A survey of the total number of tests conducted to determine feed value was made in order to get the average rate of gain of animal per pound of feed. This survey included many different meals, and each test was not conducted with the same meal: i. e., one investigator may have studied one meal while another studied a completely different meal. The meals were fed as protein supplements at the particular protein levels the investigators needed for each type of study. There were no controls in these tests. But from the survey made of tests, only 0.02 pound difference in growth rates was observed between solvent meals and those prepared by the old method of processing. You should consider that the amount of fat in the meal will affect the growth rate. Increasing fat of the ration has produced better results. In a carefully controlled experiment, one could determine the effect of lysine supplementation and other factors.

McKenzie: What are best moisture ranges for input and output from the kettles during the cooking of off-grade cottonseed, e. g., seed of 8 to 10% free fatty acids?

Fincher: Less drastic cooking conditions, considering temperature and moisture, provide less drastic treatment. This is better cooking procedure.

McKenzie: Then would you recommend more moisture?

Fincher: No, less water is recommended. At low temperature cooking, less water can be used.

Burner: Less drastic cooking usually produces a better oil from offgrade seed.

Kidd: Less rolling of the meats might help in that case, too.

Gastrock: A lesser degree of cooking, as employed in the filtration-extraction process, produced a better oil from bad seed during a bad season in the Delta area than could be produced from the same seed by other processing methods. There is a lesson to be noted: cooking can be used to improve the quality of the oil from bad seed as well as from good seed.

Pryor: What was the recommended capacity per ring for a 100″ cooker?

Fincher: Twenty tons.

Pryor: Was it a jacketed cooker?

Fincher: I think it would have to be a jacketed cooker.

Burner: From figures based on screw-press operations, we found little or no difference in cooking with or without sidewalls on cooker.

Frampton: Dr. Quinn, what are the variations among soybean oil meals?

Quinn: I can't say as I cannot speak with any authority on that question. Generally, variations are small since most soybean mills employ the same processing method.

Frampton: Perhaps Mr. Fincher might comment on that question.

Fincher: I do not know about soybean oil meals; I do know cottonseed meals vary in properties. This variability is due largely to variation in seed because of environmental conditions.

Quinn: I think the variation in cottonseed meals is much less than that in the seed.

Kidd: Mr. Fincher, you stated a preference for live steam in the top kettle of the cooker. Do you have a problem of colored oil or acid buildup from that steam?

Fincher: No. There is no problem as long as the temperature buildup is rapid. Rapid heating with live steam in a jacketed cooker with a pressure-reducer is best. Let an automatic controller handle the steam going into the kettle. If the seed is very dry, reduce the pressure and add live steam.

Pominski: Mr. Quinn, do you have any information about the ranges of moisture content in your studies?

Quinn: There was not a wide range in the moisture content.

Pominski: I think differences in moisture content could account for some differences in the ammonia content of the meals.

Quinn: The data I discussed were taken from each mill's production at a comparable moisture level.

Pryor: I know that steam and water are added to the cookers and the steam heats the water, but how do you add the live steam, Mr. Fincher?

Fincher: I think it is best to have the steam come into the cooker by pipe and have the spout of the pipe below the surface of the cottonseed meats.

Coleman: In regard to the standard deviations shown in ammonia contents of meals from different mills, we have noted that the ammonia content of seeds we purchase varies, and this initial variance of ammonia within the seed would affect the ammonia content of resultant meals.

Quinn: Yes. Those mills with the poorest quality control and showing the greatest ranges of ammonia had the greatest spread of ammonia in their raw materials.

Second Session

THE ECONOMICS OF VEGETABLE OIL COLOR

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We have been asked to discuss what role the color of oils has on the price and usability of oil for different purposes. It becomes self-evident that oils must be divided into a wide range of color specifications. This fact is attested by the fact that the "Trading Rules" of the National Cottonseed Products Association defines the color of its different oils nineteen times.

The question then becomes "what is color?" We well know that many in this audience do not need to have the abc's of color brought out to them, but in the interest of clarity we thought it best to give a few fundamental facts.

The Nature of Light and Color

When ordinary light is analyzed by means of an instrument known as a spectroscope, it is found to consist of a mixture of different kinds of light which, falling upon the eye, produces various sensations which we term colors. The analysis of daylight or arc light shows a continuous band of colors which appear to consist of three main portions—blue-violet, green, and red. If an object does not equally reflect or transmit all the different kinds of light of which white light is composed, the light coming from it to the eye will be more or less wanting in some constituents and will produce a sensation of color; so that a colored object is one which does not equally reflect or trans-

mit all the constituents of white light but which "absorbs" some. As it is the light which is not absorbed that falls upon the eye, the sensation of color produced is the reverse of, or "complimentary" to the color which is absorbed.

If objects of various colors are examined, it will be found that a light blue object has an absorption band in the red, and a yellow object in the blue-violet. The sensation of "yellow" is produced by a mixture of green light and red light falling upon the eye, the blue-violet light having been absorbed. It is this absorption in the blue-violet with which we are most concerned, because as previously noted, the "complimentary" color is the reverse cf the color which is absorbed. All oils show very marked absorption in the blue-violet. In fact, the most refined cottonseed oil shows complete absorption or zero transmission at 500 millimicrons wave-length. Blue-violet ends at that wave-length.

The Definition of Color

Light is known to consist of waves—the color of the light is connected with the length of the waves. The length of a light wave is the distance from the crest of one wave to the crest of the next, measured in mu. The millimicron (mu) is one thousandth of a micron (u) or one millionth of a millimeter (mm).

A wave of darkest violet will be 400 mu in length, a wave of bluegreen 500 mu; of bright green 550 mu, and deep red 700 mu. Visible light, then, is composed of light waves, varying in length from 400 to 700 millimicrons, which may be divided roughly into three portions—blue-violet 400-500 mu, green 500-600 mu, red 600-700 mu.

Now that we have looked into the more "mechanical" aspects of color as recorded by instruments, we should look into the more practical aspects as recorded by the human eye. It is beyond the scope of this short talk to get into the anatomy of the eye. It suffices to touch lightly on the visual variables of color and consider the appearance of color to the observer. It becomes evident that to deal with color we must deal with the psychophysical or to the many phases of the psychology of color.

It is the reaction of the observer to color that we are really interested in. When we sell our products to the baker or housewife, he or she does not (except in rare cases) take out an instrument to measure its whiteness. They consider its appearance to their eyes and will comment that the product is white, slightly yellow, yellow or grayish.

It is well known that whiteness is always associated with quality and yellow with second grade, as well as psychological effect on the buyer due to the yellowish color. This was forcibly brought out during World War II. Things were scarce—a salesman went into a bakery and the baker showed him a drum which he had to admit was on the dark side—he said that his production from this product was low. He then showed him our product packaged in a 50-lb. carton which he said gave him a high yield. The product bore the same batch number—the addition of 3% air made the difference—that is what yellow bias will do. I bring this point out because I think that the shortening industry is particularly conscious of this "yellow bias." Visual whiteness is very important to the small buyer who seldom has any other guide to judge quality by.

As whiteness is of such major importance, we thought it proper to mention the outside standard we regard as perfect 100% whiteness. We quote from Bulletin 2.1/12/5869—National Bureau of Standards:

"Magnesium Oxide Standard of Reflectance

As a fundamental standard of spectral directional reflectance nothing has yet been found more suitable than freshly prepared MgO. Its (total) luminous reflectance is 0.98 + 0.01 and nothing has been found of certainly higher reflectance. Its luminous directional reflectance for perpendicular irradiation and 45° reception is closely 1.00 and its spectral selectivity throughout the visible spectrum appears to be less than 2%. These data are based on work summarized in NBS letter circular LC-547 and in two recent publications by Benford and others (J. Opt. Soc. AM. 38, 445 and 964; 1948).

While the above characteristics make freshly prepared MgO an excellent fundamental standard, the surface is extremely fragile and its reflectance at the shorter wavelengths decreases slightly with age. Also, different preparations of MgO have been found to differ slightly in reflectance. It has, therefore, been found advisable to prepare and issue working standards of spectral directional reflectance which have been calibrated relative to freshly

prepared MgO but which will not have its fragility and impermanence."

As we never attain the perfect whiteness of MgO or the clarity of "water white" liquid, it is necessary to consider the appearance of colored objects to the observer. When light having a given spectral energy distribution enters the eye, it gives rise to the consciousness of some color. This color can be described in terms of three mental variables—called **hue, saturation** and **brightness.** Perhaps the most important of the three for everyday purpose is "hue." **Hue** may be described as the main quality factor in color. It is the essential element which leads us to name it red or green. Perhaps we may say simply that **hue** is the chief (although not the only) characteristic that gives rise to basic color names. The eye can distinguish about two hundred different hues under the best conditions.

Saturation may best be defined as the percentage of **hue** in a color. The **saturation** of a given color is described by such words as **pale** or **deep, weak** or **strong,** in connection with the name of some hue. **Saturation** is what we reduce when we bleach oils. **Saturation** and **hue** together define what may be called the **quality** aspect of the mental image caused by light.

Brightness, the third variable, may be defined as the **Quantitative** aspect of the mental image. It describes the appearance of the image in terms of the apparent amount. I would like to insert here a mental aspect of color with which you are familiar. Blueing is added to make white clothes appear whiter. The thing which was actually done was not to raise the reflection factor of the clothes but to **lower** it. The reason the clothes appear whiter is that we have **straightened out** our reflectance curve, making all the different kinds of light of different wavelengths coming to the eye about equal, giving less variations which the eye can perceive and calls "color." Actually, the clothes are less yellow but grayer.

It is a well known fact that when green pigment is added to dark vegetable oil, the Lovibond color is reduced—the oil appears lighter.

Here we might challenge the logic of the Photometric color of the A. O. C. S. which subtracts the density reading from the formula.

$$\textbf{Photometric Color} = 1.29\ C_{460} + 69.7\ D_{550} + 41.2\ D_{620} - 56.4\ D_{670}$$

Note that the green 670 is subtracted. Here we give credit for removing color where we should give a debit for adding green pigment. This green pigment is difficult and expensive to remove.

The trading rules of the N.C.P.A. have definite penalties for color of off crude C/S oil and peanut oil—where crude oil is delivered as prime, basis prime, off or reddest off crude contract, seller shall pay buyer at the rate of ½ of 1% of the contract price for each 1 point in excess of A.O.C.S. color 7.6 in the case of cottonseed oil or A.O.C.S. 5 in the case of peanut oil.

The deduction is made only on the weight of refined oil produced, and at the current price of 10 cents a pound for crude, the approximate deductions are as follows:

TABLE I

A.O.C.S.— Points Red Over 7.6	Cents Per Pound Deduction/ 100-Lb. Crude
1	.0455
2	.0910
3	.1365
6	.2730
8	.3640
10	.4550

We have taken a prime loss of 9% in each of the above cases (calculated on a 60,000-Lb. car, this dockage amounts to from $27.00 to $273.00 a tank car).

Our standard for quality hydrogenated products is 9 yellow, .9 red maximum melted, and 70% reflectance, as compared to magnesium oxide mentioned above. This must be obtained with a 0.825 gravity.

It becomes obvious that any "off" oil to be usable to us must go through considerable refining and bleaching. We also have the fear that "off" oils will revert in color when worked or re-refined too much.

In conclusion, the importance of light on white oils and shortenings has been brought out. The fact that whiteness has always been associated with purity is significant. The first and most important thing a baker or housewife will do is to scrutinize its color and possibly judge the performance of the shortening on its color. The complicated psychophysical as-

pects must be considered, such as viewing conditions, kind of light reflected, color of surroundings, etc.

The present method of deductions for "off" color which gives credit for green pigment should be looked into. We might summarize by saying that we always have to guard against "yellow bias."

HOW COLOR BECOMES FIXED IN COTTONSEED OIL

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Difficulties experienced in removing fixed pigments from an estimated 25% of current crude oils by conventional refining and bleaching methods is a real problem of interest to all of you here. Intensive study of this problem over the past few years has shown that "color fixation," whereby alkali insoluble and bleach resistant pigments appear in the crude oil, can develop during storage of the seed prior to processing, in immature or damaged seed, or can be brought about by conditions existing during processing of the seed. Another fixation reaction, commonly referred to as "color reversion" occurs in crude oils after processing, particularly after storage at elevated temperatures. The latter, "color reversion," is probably the most important since the majority of crude oils are susceptible to the reaction in varying degrees.

How color becomes fixed in crude oils is an ambitious title for this talk, as we must admit that at the present we do not know the complete answer to this question. What we do know from the weight of the evidence which has accumulated is that undoubtedly reactions of gossypol either with glycerides, or with oil soluble constituents of the seed is responsible for this problem. It has been adequately demonstrated that removal of gossypol from the crude oil by suitable processing techniques or by chemical treatment (of which treatment with p-aminobenzoic acid is an example) immediately after expression of the oil prevents "color reversion" of the crude oils. Immediate alkali-refining is another way to achieve the same result.

An example of the effect of gossypol on color reversion is given in the first slide.

Here the increase in bleach color of experimental screw-pressed oils after storage of the crudes for 40 days at 100° F., is plotted against initial gossypol pigment content of the crude oil. The relationship is good and indicates that besides temperature, rate of reversion is governed by the gossypol concentration. The relation has been found to be generally true for other oils, although not always as striking as the one shown here.

That gossypol pigments of some form are related to color reversion is demonstrated by the data in the second slide.

When the gossypol content of the refined and bleached stored screw-pressed oils is plotted against bleach color, again a good relation is found. Oils stored at low temperatures (lower part of curve) are low in bleach color and in gossypol pigments. Also note that the concentration of gossypol by analysis is low, the highest values being about 0.003%. Qualified by the possibility that some of the fixation pigments may not be measured by the analytical procedure used, these data suggest that rather high bleach color can be caused by reaction of small amounts of gossypol. Or, in another form, although gossypol concentration at a given temperature governs the rate of reversion, the extent of the reaction does not have to be complete to produce high bleach color.

These data are presented to emphasize the fact that time and temperature of storage and the concentration of gossypol, or perhaps gossypol derivatives, in crude oils are responsible for the color fixation problem.

We would like now to outline for you some of the approaches we are utilizing in our present work on this problem. The need for a more thorough understanding of the chemistry of color fixation has initiated a study of model reactions of gossypol with glycerides, esters and other simple systems. From controlled experiments it may be possible to isolate fixation pigments for characterization. At the same time we are also endeavoring to isolate and characterize the fixed pigments from

natural off-colored refined and bleached oils. In the final anlysis, knowledge of the chemistry involved, and of the nature of the fixed pigments, will allow intelligent measures to be taken for alleviation or elimination of the color problem.

One of the model systems studies is the reaction which occurs when refined and bleached oil containing added gossypol is heated under anaerobic conditions. Under these conditions, a fixation reaction occurs: part of the gossypol becomes alkali-insoluble and the oils undergo a transformation to an orange-red color. The data shown on the third slide where the reciprocal of the unreacted gossypol concentration at a given time is plotted against reaction time at three temperatures indicate a second order reaction which is extremely temperature dependent. The second order reaction indicates one in which two molecules of gossypol enter the reaction simultaneously.

The spectra shown in the fourth slide represent the fixation product formed after reaction of 70, 200, and 500 hours at 60°C. and are all characterized by a single absorption maximum at 365 millimicrons.

When the data from the previous slide are calculated and plotted in terms of absorbtivity (extinction coefficient) it can be seen in the fifth slide that the fixation pigment (Curve 2) is different from gossypol (Curve 1). Of importance is the fact that in the visible region from 400 to 500 millimicrons the absorbtivity of the fixation product is **higher** than that of gossypol, causing the dark orange-red color.

Another model reaction studied has been the reaction between gossypol and ethyl acetate, a simple ester. Here again (in slide 6) a fixation reaction occurs as shown by the spectra representing the system before (Curve 1) and after (Curve 2) alkali extraction to remove unreacted gossypol. The product from this reaction has been isolated and identified as anhydrogossypol which has spectral characteristics identical with Curve 2. Anhydrogossypol which is produced from gossypol by elimination of two molecules of water has so far not been found in any crude, refined or bleached oils. The model reaction, along with the gossypol-glyceride reaction, does indicate that ester groups participate in the reaction. No fixation has been observed when gossypol is heated in mineral oil or solvents which do not contain ester linkages.

Data in the previous slides suggest that a gossypol-glyceride fixation product with an absorption maximum at 365 millimicrons may be one of the fixation pigments in oils. To explore this possibility, a number of oils were refined and bleached by A.O.C.S. official methods. When the absorbance (Optical Density) of the refined oils is plotted against bleach color obtained by a spectrophotometric method, a relationship is obtained (slide 7) with a correlation coefficient of + 0.97. This would seem to confirm the presence of a gossypol-glyceride fixed pigment in crude oils, although positive confirmation will require isolation and characterization of these fixed pigments.

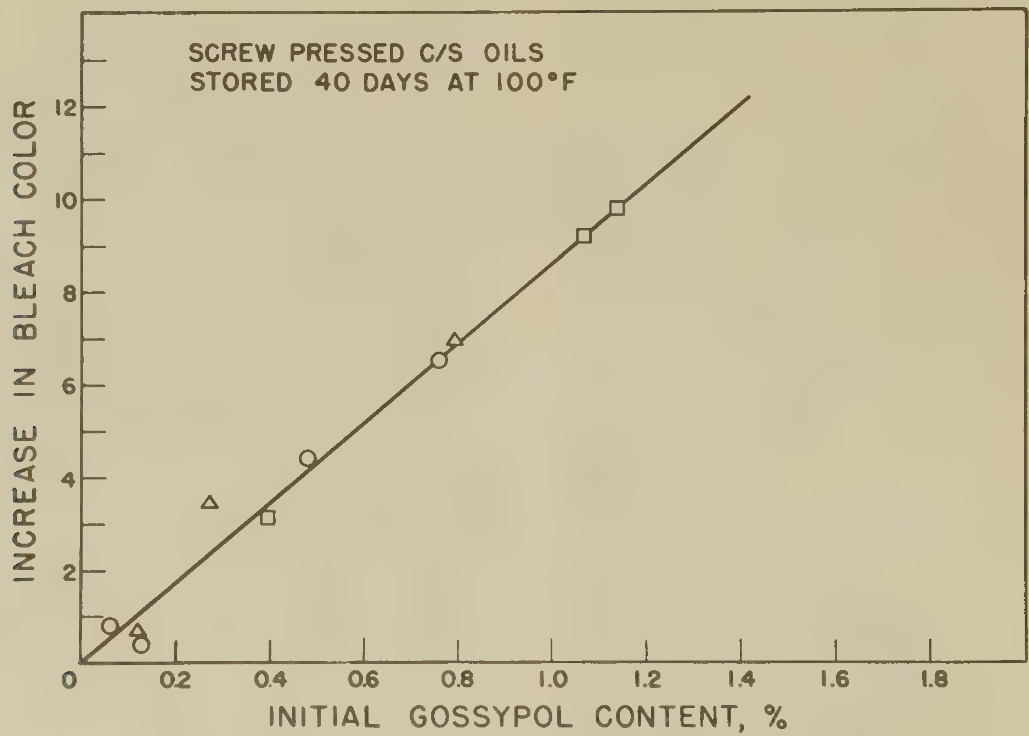
Finally we would like to show you some results from a study of more active bleaching agents for the removal of these bleach-resistant fixed pigments from cottonseed oils. Bleaching such an oil with progressive amounts of natural or activated earths has practically no effect on color removal (First Two Columns, Slide 8). From a number of absorbents investigated, activated aluminas were found to be reasonably effective for removal of these pigments, as is illustrated by the LAST COLUMN in this slide. For the oil shown here, it was calculated from bleaching isotherms that 36 times as much natural earth, as alumina, would be required to bleach this oil to 3.0 color units.

The use of diethylene triamine in the alkali for refining has previously been reported from this Laboratory as an effective means for removing fixed pigments from crude oils. The limited data shown on slide 9 were obtained on two off-colored crudes to explore the feasibility of alumina bleaching for the same purpose. As you can see, it suggests that alumina bleaching also shows promise as an effective means for removal of fixed pigmentation.

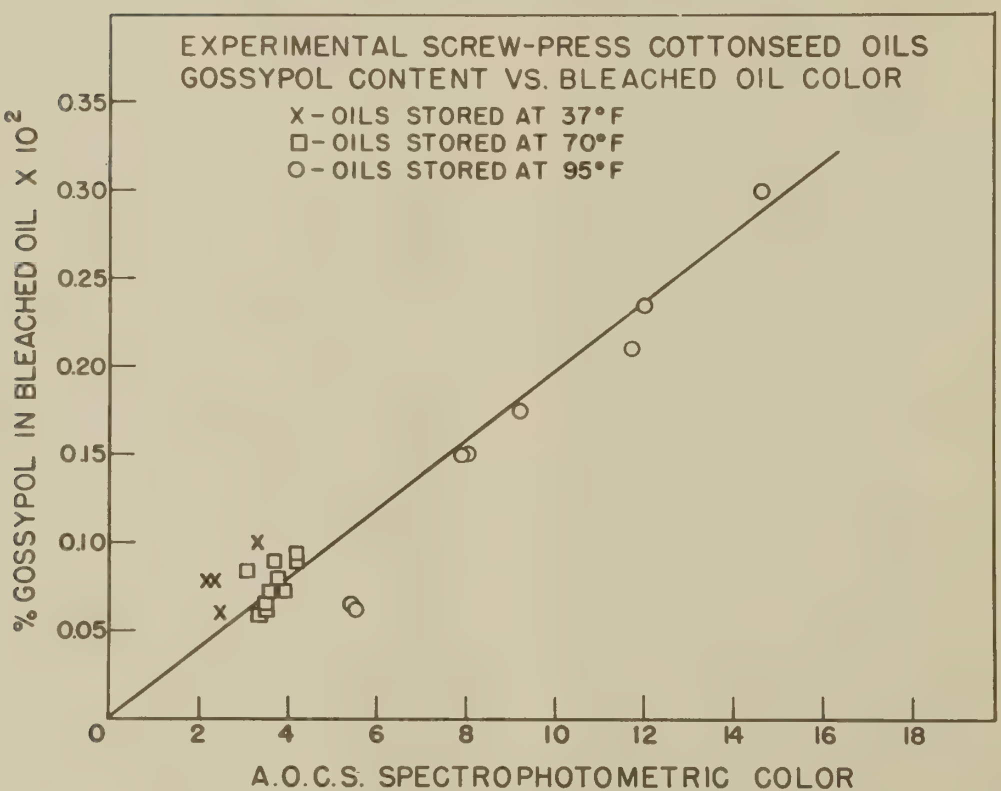
In this last slide (10) we have listed bleaching results for seven off-colored oils treated with equivalent amounts of natural earth and alumina. It is evident that in all cases alumina bleaching removes considerable fixed pigmentation. The starred sample (Sample A*) is a synthetic product prepared by heating refined and bleached oil containing 0.5% pure gossypol, until color fixation occurred. The effective removal of this fixed pigment with alumina is striking. Also of note is the fact that refined color of the oil bears no apparent relation to the final bleach color.

This study has recently been completed and

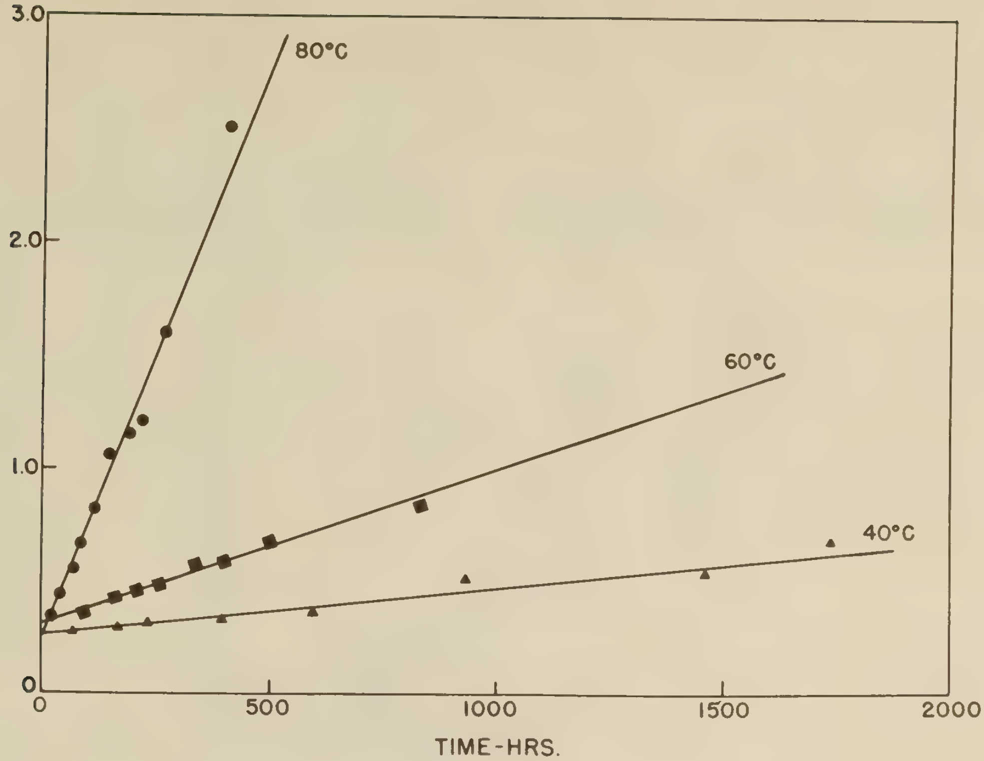
a more complete report will be given at the Spring Meeting of the American Oil Chemists' Society, as we thought you might be interested in some of these results.



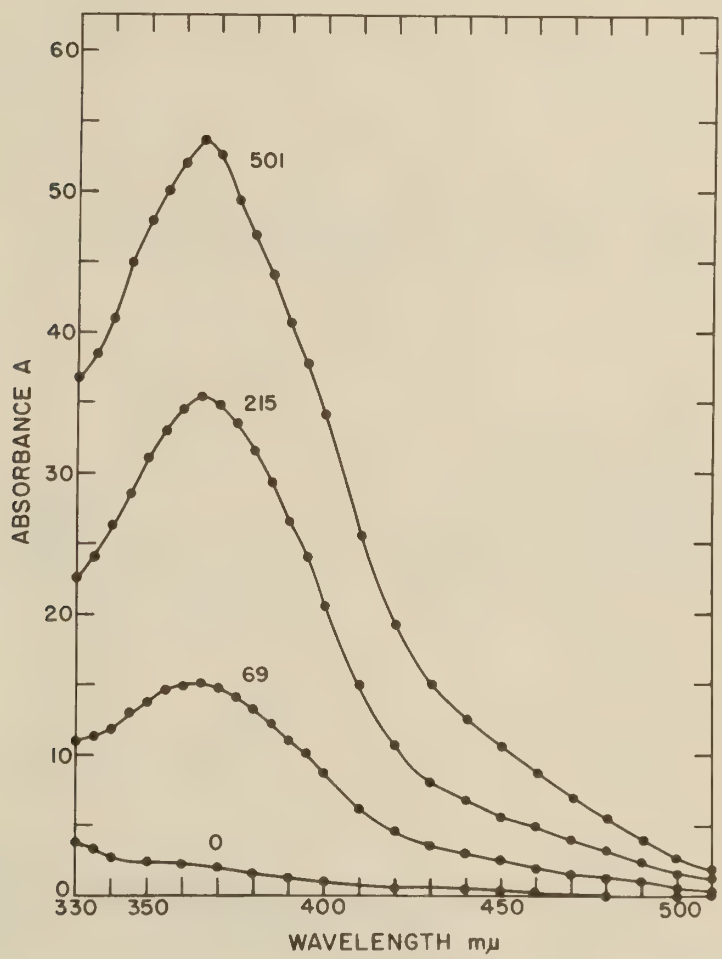
SLIDE 1



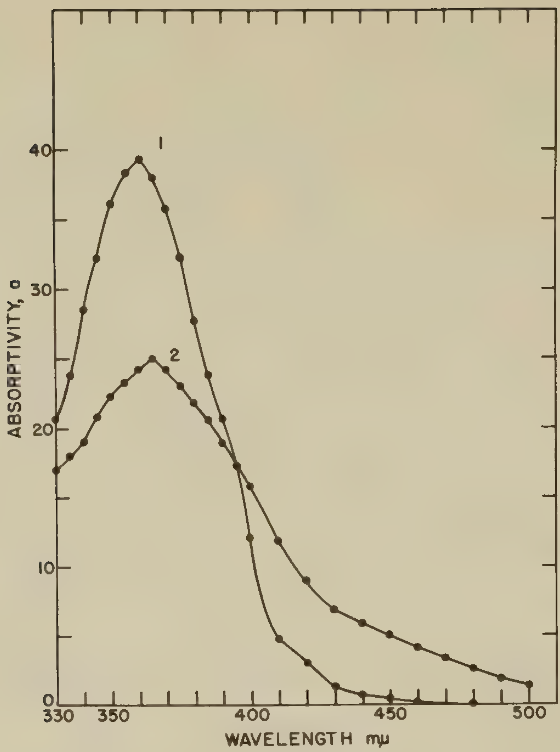
SLIDE 2



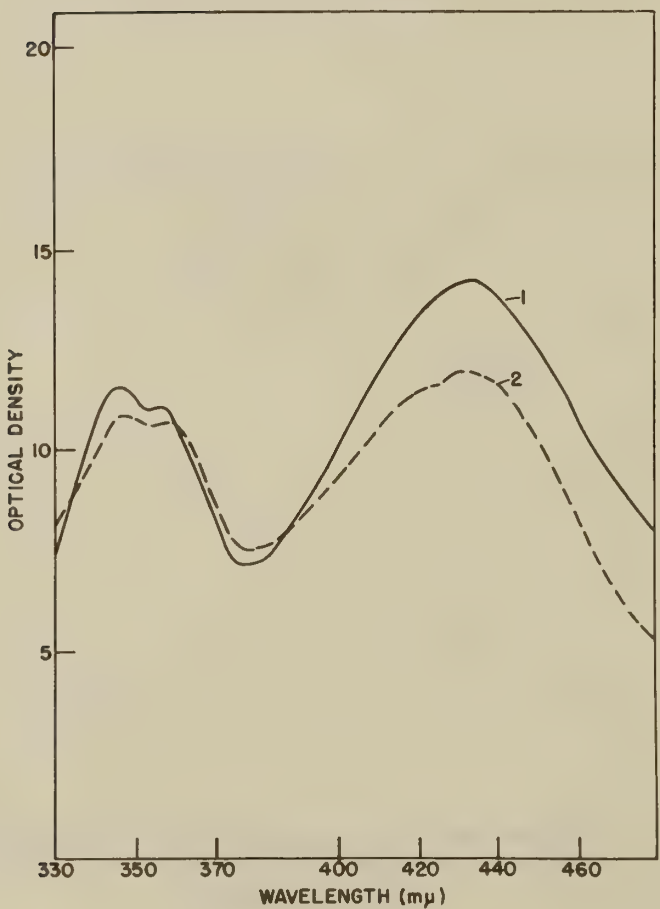
SLIDE 3



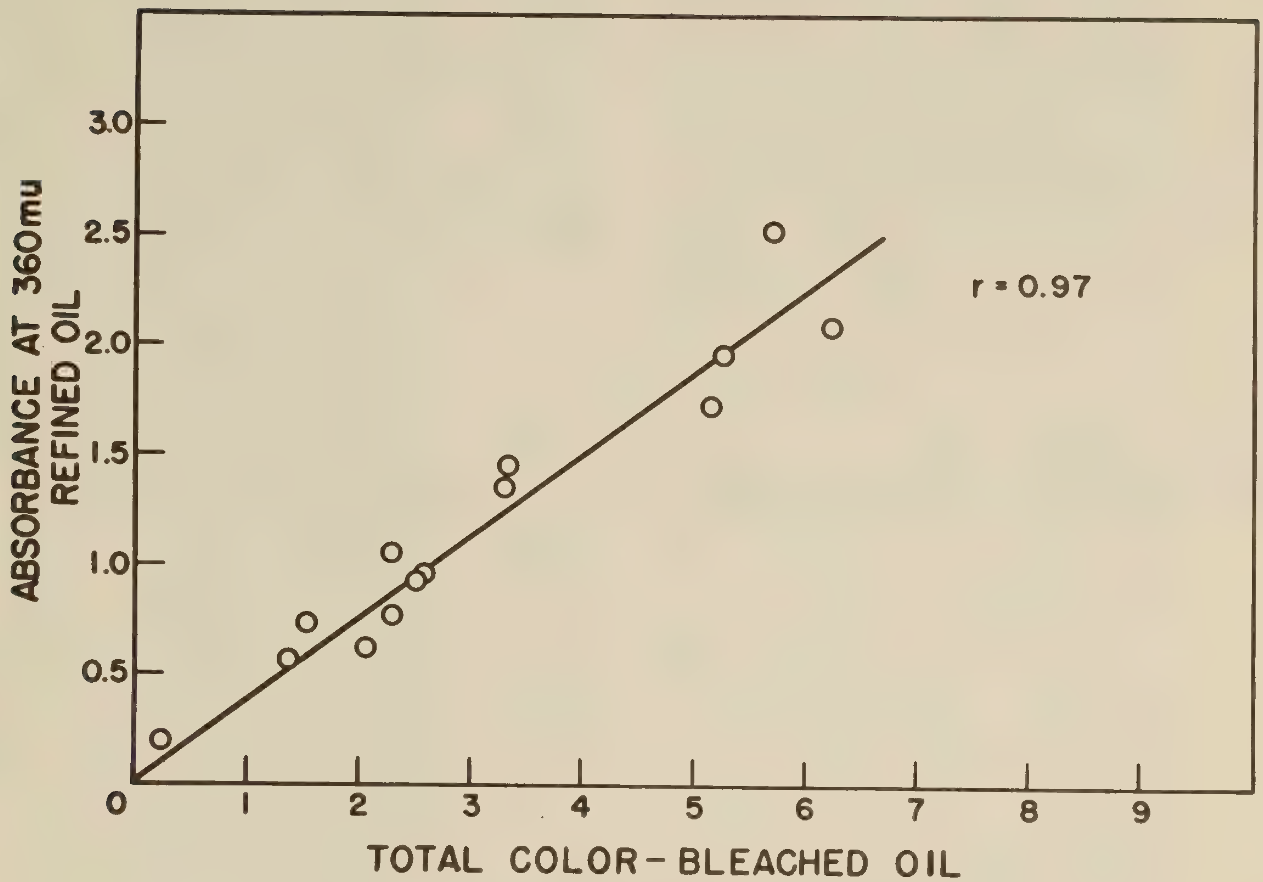
SLIDE 4



SLIDE 5



SLIDE 6



SLIDE 7

Slide 8.—*Fixed Color v. s. Adsorbent*

Adsorbent %	Bleach color		
	N. Earth	A. Earth	Alumina
1	7.6	7.7	4.6
2	6.8	6.7	3.4
3	6.2	5.9	3.1
4	6.0	5.3	2.9
5	6.1	4.7	2.8
6	5.4	4.4	2.6

Slide 9.—*Methods For Reducing Fixed Color*

Cup Ref. N. Earth Bl.	Centr. Ref. 2% D.T.A. N. Earth Bl.	Cup Ref. Alumina Bleach
6.2	2.4	2.9
5.7	3.4	2.9

Slide 10.—*Bleaching Off-Color Oils*

Oil	Ref. Color	Bleach Color	
		4% Earth	4% Alumina
A*	12.8*	11.7*	4.0*
B	12.5	6.0	2.9
C	14.7	5.7	2.9
D	13.0	5.3	3.2
E	17.1	4.8	3.6
F	10.4	4.6	3.1
G	13.4	2.8	2.0

* Gossypol in Oil-Heated

Panel Discussion

Moderator: J. H. Brawner.

Members: P. A. Williams, W. A. Pons, Jr., J. R. Mays, Jr., E. H. Tenent, Sr., Allen Smith, C. A. Wamble, T. H. Hopper, G. C. Henry.

Kidd: Have refiners done anything about improving refining methods?

Williams: No new or revolutionary methods in years. Re-refining is the standby for handling dark oils. Blending good and poor oils is not usually successful, the blended oil tends to have the quality of the worst oil. The most recent thing that I know of in refining is solvent refining. I am not too familiar with this process.

Frampton: How much added cost could the refining process stand? This knowledge would be helpful to us in guiding our research.

Williams: That is difficult to say. Re-refining is expensive, about ¾ to 1 cent per pound, including oil loss, lye, labor, etc. Bleaching also costs, you lose about 30 lbs. of oil per 100 lbs. of clay. The maximum amount of bleaching earth which we can afford to use is 1.2% of the oil weight. One bleach is the limit. If this will not do it the oil is re-refined. Some oils simply cannot be lightened to shortening color.

Frampton: Then we can assume a cost limit of about ¾ of a cent per pound of oil treated?

Williams: First of all the Food & Drug Administration must pass anything you use. It must not adversely affect the oil quality. Any new treatment would have to be at least as cheap as re-refining.

Quinn: Is there any correlation between refined and bleached color?

Williams: No.

Pons: There is no correlation between refined and bleached color that we could find. The mixture of pigments in different oils varies, some of these pigments are easily removed, some cannot be removed.

Quinn: If producers could produce better quality oil, would refiners be willing to pay more for it?

Wamble: Some mills can now produce better oil than they do. There is no advantage to them for doing this under the present trading rules.

Moore: There is no premium for light refined oil. No mill is going to the extra cost under these circumstances. Would it not be to the refiners' advantage to pay the mills for producing bleachable oil of better than 2.5 red.

Woodruff: A good many mills have found out it does not pay to get too much bad oil on hand either. It just won't move sometimes.

J. H. Brawner, Chairman, read a copy of the committee's report on hidden oil losses.

HIDDEN OIL LOSSES

J. H. Brawner
Wesson Oil & Snowdrift Co., Inc.
New Orleans, La.

Last year, I reported the results of some statistical work that was done in an effort to learn something about the so-called "unaccounted-for" oil loss that has been giving us trouble, especially in recent years. As a final result of our discussions, I was directed by the group of people here at the Clinic to form a committee to study hidden oil losses. This committee was formed and has begun to function.

It seems to me that the statistical work we had done with actual cleanups might be a concrete starting point for the committee in its investigations. Therefore, all the available data were reworked and checked and presented to the committee.

These final data seemed very interesting to me; so in the hope that you also will find them interesting, I am going to show them

to you.

First, we tried to find if there were any indications of differences in "unaccounted-for" oil loss between hydraulic and mechanical pressing. After one or two false starts, we hit upon the idea of studying mills that had changed from hydraulic to mechanical pressing and of comparing results obtained before and after the change. Table I shows how we came out.

From Table I, it appears that an increase in "unaccounted-for" oil loss occurs when a mill changes from hydraulic to mechanical pressing. The typical amount of increase is approximately 6 pounds.

adequate protection against moisture loss was given to all the receipts samples. Therefore, the possibility existed that the relationship between seed moisture and "unaccounted-for" oil loss was the result of nothing more than unmeasured moisture loss.

The same sort of thinking can apply to the significant relationship between "unaccounted-for" oil loss and the "accounted-for" oil loss. In most hydraulic mills, the meal cooks take the press room cake samples. In the past, we used cake analyses instead of meal analyses in our calculations. It has been my personal experience that it is almost impossible to get a meal cook to take a representative sample from cake being produced by poor operation. Almost invariably the cook will tend to get a sample that is "too good." Since some of the hydraulic results we used in our calculations were from the period when cake samples taken by cooks were used to judge press room work, it is not surprising that we found a greater "unaccounted-for" oil loss when the "accounted-for" oil loss was higher than normal.

TABLE I

Mill	Hydraulic Pressing Years Used	Hydraulic Pressing Average Unaccounted-for Oil Loss*	Mechanical Pressing Years Used	Mechanical Pressing Average Unaccounted-for Oil Loss*	Mechanical Pressing Unaccounted-for Loss Minus Hydraulic Unaccounted-for Loss
A	3	13 lbs.	3	14 lbs.	+ 1
B	3	6	3	8	+ 2
C	3	7	3	9	+ 2
D	3	7	3	12	+ 5
E	3	5	3	11	+ 6
F	3	9	3	15	+ 6
G	3	5	3	12	+ 7
H	3	(4)	3	3	+ 7
I	3	10	3	17	+ 7
J	3	1	4	9	+ 8
K	4	1	4	10	+ 9
L	3	3	2	14	+11
Average	—	—	—	—	6

* "Unaccounted-for" oil loss is pounds of oil in seed purchased minus pounds of oil yield minus pounds of oil in meal minus pounds of oil in hulls.

After satisfying ourselves that mechanical pressing tended to produce a higher "unaccounted-for" oil loss than hydraulic pressing; we tried to learn from our cleanup studies just what factors might be related to "unaccounted-for" loss in hydraulic pressing and in mechanical pressing.

First, we investigated hydraulic operation. Table II gives a summary of data representing 148 annual hydraulic cleanups from 44 mills over a period of up to 6 years.

When we studied these correlation coefficients for hydraulic processing, we were not very surprised that seed moisture was apparently related to "unaccounted-for" oil loss, because many of the results came from an earlier period when there was some doubt that

As for percent FFA in oil in seed, no explanation has been found for its apparent relationship to hydraulic "unaccounted-for" oil loss. Here, then, may be a factor that is worth further investigation.

After studying hydraulic operation, we made essentially the same kind of analysis for mech-

TABLE II

Factor Correlated with "Unaccounted-for" Oil Loss	Pearsonian Correlation Coefficient	Significance of Correlation Coefficient from Fisher's Tables
% Moisture in Seed Bought	+0.2427	Very significant
% Oil in Seed Bought	−0.0655	Not significant
% Oil in Seed Crushed	−0.0921	Not significant
% FFA in Oil in Seed Crushed	+0.2196	Very significant
Lbs. of Accounted-for Oil Loss	+0.2401	Very significant
% Moisture in Seed Bought, % FFA in Oil in Seed Crushed, and Accounted-for Oil Loss, all taken together	+0.4493	Very significant

Notes

1. "Accounted-for" oil loss is lbs. of oil in meal plus lbs. of oil in hulls.
2. "Unaccounted-for" oil loss is total pounds of oil in seed purchased minus oil yield minus accounted-for oil loss.

anical pressing. Table III gives the results for 46 annual cleanup reports for 15 mills over a period up to 6 years.

The mechanical pressing results; which, in many cases were more recent than the hydraulic results; indicated that the relationship between seed moisture and "unaccounted-for" oil loss apparently had disappeared. Our hypothesis that faulty care of seed samples may have been the cause of an apparent relationship in the case of hydraulic operation now perhaps is strengthened, since many of the mechanical press results were gotten during a period when more attention was given to care of samples.

With mechanical pressing, for some reason there appeared to be a definite relationship between oil in seed and "unaccounted-for" oil loss. Oil in seed purchased and oil in seed crushed both were definitely and independently related to "unaccounted-for" loss. I say "independently" because each of the correlation coefficients was based on different analyses of different samples taken by different people at different times.

The mechanical pressing data indicated that there was a definite relationship between FFA in oil in seed and "unaccounted-for" oil loss. Since FFA was related to "unaccounted-for" loss for both hydraulic and mechanical pressing, it must be an important factor that should be given careful consideration in future investigations of "unaccounted-for" loss.

TABLE III

Factors Correlated with "Unaccounted-for" Oil Loss	Pearsonian Correlation Coefficients	Significance of Correlation Coefficient from Fisher's Tables
% Moisture in Seed Bought	+0.2458	Not significant
% Oil in Seed Bought	+0.3615	Significant
% Oil in Seed Crushed	+0.2968	Significant
% FFA in Oil in Seed Crushed	+0.3068	Significant
Lbs. of Accounted-for Oil Loss	+0.0885	Not significant
% Oil in Seed Bought and % FFA, Taken Together	+0.4596	Very significant

Notes

1. "Accounted-for" oil loss is the lbs. of oil in meal plus the lbs. of oil in hulls.
2. "Unaccounted-for" oil loss is the total lbs. of oil in seed purchased minus oil yield minus accounted-for oil loss.

I would like to add one other piece of information to what has just been given. At one of our Processing Subcommittee meetings, Mr. H. D. Fincher suggested that someone should try to make oil "disappear" by intense cooking. Mr. Shaw of our Company and Mr. Bradham of Barrow-Agee Laboratories in Greenville have tried to do just that. They made a small cooker, and heated cottonseed meats in it to high temperatures. Table IV shows the results of their efforts.

It is very peculiar that the apparent oil content tended to **increase** as the intensity of cooking increased. This could be caused by some undetected difficulty in connection with moisture determination under unusual conditions, or it could be caused by some chemical breakdown. At any rate, there was no obvious oil "disappearance" under severe cooking conditions.

From all of the foregoing data, several things stand out. First, mechanical pressing apparently gives an "unaccounted-for" oil loss 6 to 7 pounds higher than hydraulic pressing. Secondly, percent FFA in oil in seed somehow seems to be related to the "unaccounted-for" oil loss in both hydraulic and mechanical pressing. Thirdly, in mechanical pressing, the percent oil in seed somehow seems to be related to "unaccounted-for" loss. Lastly, very intense cooking apparently does not cause oil to "disappear." This suggests that any "binding" or "fixing" of oil in hydraulic or mechanical press operation possibly occurs during actual pressing.

Comments from the panel were then called for.

The following statements on hidden oil losses were read into the record by G. Conner Henry and by A. Cecil Wamble.

Henry: It is generally known or suspected that oil losses occur in the milling of cottonseed by screw press or expeller equipment that is in excess of that amount lost in hydraulic processing.

It is further suspected that some oil is "fixed" in the cake and is not extractable by petroleum ether which is commonly used in the laboratory determination of residual oil in cake or meal.

We have made no attempt to find out how the oil may be "fixed" in the cake but have done limited work to get an approximate idea

TABLE IV

First Test, with Open Cooker and Poor Agitation			Second Test, with Covered Cooker and Good Agitation			Third Test, with Covered Cooker, Good Agitation, and 16-hr. Predried Pure Meats		
Time (Min.)	Meats Temp. (F.)	% Oil (D. B.)	Time (Min.)	Meats Temp. (F.)	% Oil (D. B.)	Time (Min.)	Meats Temp. (F.)	% Oil (D. B.)
0	192	30.1	0	. . .	30.5	0	. . .	38.6
15	176	30.7	12	200	30.6	12	240	38.3
30	188	30.7	33	215	30.3	18	255	38.5
35	210	30.8	45	230	31.2	25	270	38.3
50	217	30.7	52	245	31.4	32	285	38.7
60	225	30.5	57	260	31.5	40	300	38.7
70	230	31.0	64	275	31.7	53	315	39.5
75	250	31.1	70	290	31.4	100	315	40.2
78	260	31.0	75	305	31.5	115	340	40.4
80	270	31.3	79	320	31.5			
86	280	31.4	84	335	31.7			
89	290	31.4	90	350	31.9			
92	305	31.1	96	365	32.0			
95	320	31.6	101	370	32.5			
100	325	31.7	106	368	32.7			
103	330	31.5	111	362	32.8			
105	340	31.5	116	358	31.8			
108	350	31.6	121	360	33.0			
110	360	31.2	126	365	32.0			
115	370	31.1						

of how much oil is not extractable by petroleum ether from cake processed mechanically.

Two samples, one cake and one meal, were extracted fully with petroleum ether and subsequently processed to liberate the fixed oil as the fatty acids.

The procedure used was as follows: The sample, after complete extraction with petroleum ether was refluxed with alcoholic KOH for 30 minutes to saponify any fixed oil and separate it from the meal. The alcohol was removed by evaporation and 50 ml. of water added. This was then made acid and the liberated fatty acids were wet extracted and weighed. The fatty acids were converted to equivalent oil using a factor of .95 by which the amount of fatty acids were divided.

Results obtained on the two samples were as follows:

Sample	Mill Yield	% Free Fatty Acids Recovered
Cake	781#	0.51%
Meal	1054#	0.39%

Sample	Equivalent Oil	Lbs. of Oil per ton of Seed Crushed
Cake	0.54%	4.2
Meal	0.41%	4.3

We wish to emphasize that no general conclusions can be drawn from the above results for several reasons.

1. Only one experimental attempt was made.
2. Only one day's work was examined from one mill.
3. It is not known that all of the oil was recovered from the cake and meal by the process used.
4. "Fixed oil" may vary from mill to mill and in the same mill from day to day.
5. "Fixed oil" may vary, and probably does, between cake made from good seed and cake made from damaged seed. Further variations may be encountered between cake made from field damaged seed and cake made from house damaged seed.

This limited experimental approach suggests that a certain amount of oil is "fixed" in the cake in such a manner that it is not extracted by petroleum ether. It is also indicated that the "fixed" oil is of sufficient magnitude to account for a large part of the invisible losses.

It is not necessary to point out that oil in cake not found and reported by the laboratory shows up as a loss of oil when the material balances are calculated.

Since the recovered oil does not account for the large losses that some operations experience, it may be further assumed that there are other losses than "fixed" oil that are not being accounted for.

Any study of this phase of the problem should determine what, if any, oil may be "fixed" in uncooked cottonseed meats.

Wamble:

1. Obtain samples of cake and also the vapors coming from Screw Presses (Expellers) in mills having trouble with unaccounted-for oil loss.
2. Extract cake samples with solvents which might be expected to extract materials which might have once been oil or fatty acids, phosphatides, etc., but due to heat and pressure in the Screw Press being changed to something not soluble in petroleum ether. These extracts should then be examined for anything that might have ever been a part of what is extracted and weighed as oil.
3. Cottonseed meats might be treated under conditions of high temperature and pressure such

as might be expected to exist (or even higher) in Screw Presses (Expellers) in order to determine if less soluble substances can be formed from the normal constituents of the oil.

4. The vapors coming from Screw Presses (Expellers) should be analyzed to determine how much oil is atomized into the atmosphere (if any). These vapors should be analyzed for any volatile fragments of anything that might have once been a constituent of the oil.
5. This work could probably best be done by the Southern Regional Laboratory. The Cottonseed Products Research Laboratory could cooperate in the work by working with operating mills. Getting samples under carefully controlled operating conditions is an example of one of the services the laboratory might perform for the project.

Smith: It is my opinion, based on observation over the years that those losses are real, and occur during the cooking operation.

Tenent: There has been much complaint of oil losses over the past ten years from expeller or screw press mills, but not from solvent mills. I doubt that some of the low residual oil results reported for expeller operations are real. I think that the oil is there, but is bound in some way to the protein, so that extraction with petroleum ether will not get it out.

Mays: We have records going back 38 years showing hidden oil losses in both hydraulic and screw press mills. The problem is complex and it needs study. This work should be done right here at SURDD. These losses always range from 2 to 10 pounds. Some mills get good balances; others miss by 12 pounds. The material reported by Conner Henry has been found by us in both hydraulic and screw press meal.

Hopper: The apparent oil losses are due to lipids bound to the phospatides in the meal. These lipids do not show up as oil in the present methods of analysis, which were developed 30 years ago for hydraulic pressed materials. These methods are empirical, and were worked out to reflect the material balances in hydraulic operations. We need to have another look at our methods of analysis.

Fincher: (to Allen Smith) Do you discount the high temperatures and pressures in the expeller barrel as a factor in these oil losses?

Smith: I believe it happens in the top kettle of the cooker, not in the expeller. The big factors are time, temperature and moisture.

Williams: (to Conner Henry) Would it be fair to assume that in the determination of non-extractable oil, the original seed was also examined for this material?

Henry: That was taken into consideration.

Brawner: Is it true that the lower the residual oil the higher the loss?

Mays: All of the factors are interrelated.

Kidd: Is there any difference in quality of hydraulic and screw pressed oil?

Brawner: We have evidence that the oils are comparable—perhaps over the long pull, hydraulic is a little bit the better.

Woodruff: Would it not be better to leave the non-oil material in the meal?

Brawner: It may be.

Wingard: In our experience with soybean mills, we get them set up and in satisfactory operation, then the engineers went in to get a material balance. They were not able to do this in four years of trying, and finally gave up. It boils down to this: The output materials are so different from the input materials, you are trying to balance unlike things, and they just won't balance.

Third Session

IMPROVED SEED COOLING

Walter Johnson
Memphis Cotton Oil Co.
Memphis, Tenn.

Hot cottonseed in storage is probably one of the most feared conditions an oil mill operator can face.

Feared, because he knows that unless prompt and effective action is taken, an accelerated deterioration of even a much larger tonnage may be expected, resulting in a loss of quality in lint, hulls, meal and oil, and a subsequent loss in dollars.

Cottonseed have been known to heat until spontaneous combustion resulted. In other instances, although combustion may not have occurred, the effect was the same, with only a mass of carbonaceous material remaining:—a complete loss.

To a lesser degree, the lint may appear scorched and the meal darkened with a burnt odor. Any appreciable degree of heating will cause an increase in free fatty acids and refining loss plus a darker red color of the refined oil.

To forestall cottonseed heating and the economic losses that invariably follow, the Armour & Company Mills decided in 1946 to improve the aerating system in their Muskogee type seed houses.

It might be pointed out here that this decision was not made during a lazy summer afternoon but rather in the late fall with a house nearly full of seed that were beginning to heat, despite the fact that lateral air system was in use.

The heating occurred near and above the tunnel. This characteristic had been observed many times before, and, as always, no serious temperature rise was evident near the outer edges of the pile where the seed was not compacted.

It was thought perhaps the density of the seed near the tunnel was the condition which promoted heating. However upon further examination of this thought it is easy to see the greatest density is in the seed next to the floor which seldom, if ever, generated heat of its own accord. Therefore density alone did not appear wholly responsible.

With the house better than ¾ full of seed, and the existing cooling system going day and night, the temperatures above the tunnel continued to rise while the temperatures toward the outer edges showed a slight decrease. This could mean only one thing: The flow of air was following the path of least resistance, or density, and entering the lateral ducts from the outer lower levels of the pile and through the tunnel opening near the floor, with an insufficient amount of air flow above the tunnel, which allowed the seed to continue heating. Looking at a cross-section of the Muskogee type seedhouse will possibly show why this condition existed. See diagram No. 1.

The Muskogee type house is designed to conform to the natural shape of a pile of seed; that is, the normal angle of repose of cottonseed is considered to be about 45°. The slope of the roof on this type house is 45° on each of the four sides. Therefore it is to be assumed that when seed are discharged at the top of the house, and repose at an angle of 45°, the seed would nestle under the roof without the need of additional handling in order to fill the voids. This is not the case in most instances; first, because the discharge conveyor is not mounted at the apex of the roof line, although various types of chutes help to overcome this and, secondly, the angle of repose is frequently greater than 45°. For either or both reasons, there is generally considerable air space between the seed pile and the walls or roof.

Unless this space is needed to utilize the maximum capacity, little effort is directed toward leveling out the seed and stowing against the walls and roof. When seed have not been stowed, the air flow may be expected to follow the pattern indicated in diagram No. 1.

In studying the design of the cooling system of the Muskogee type house it is apparent the engineer proposed to have the seed stowed against the walls to prevent lateral seepage thus directing the flow of air downward regardless of the height of the pile. It is also probable that some form of bulkhead in the

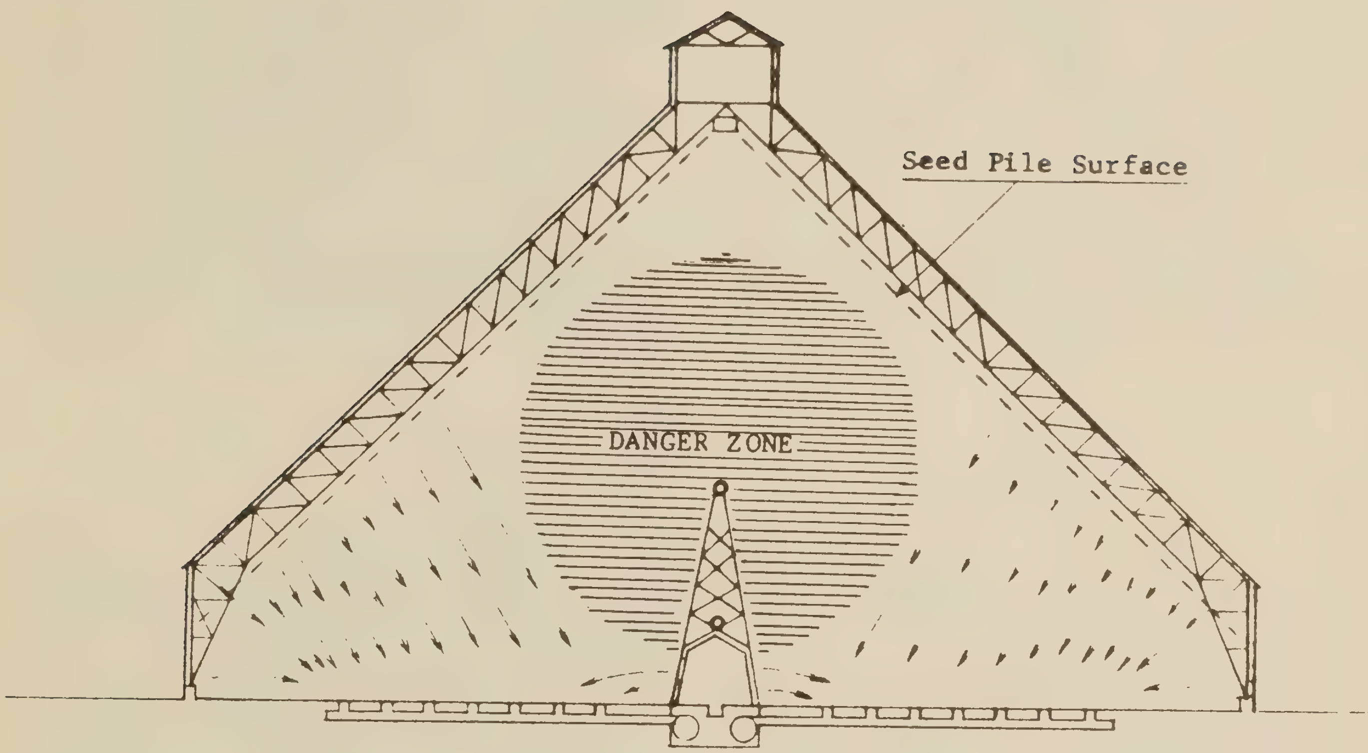


DIAGRAM #1

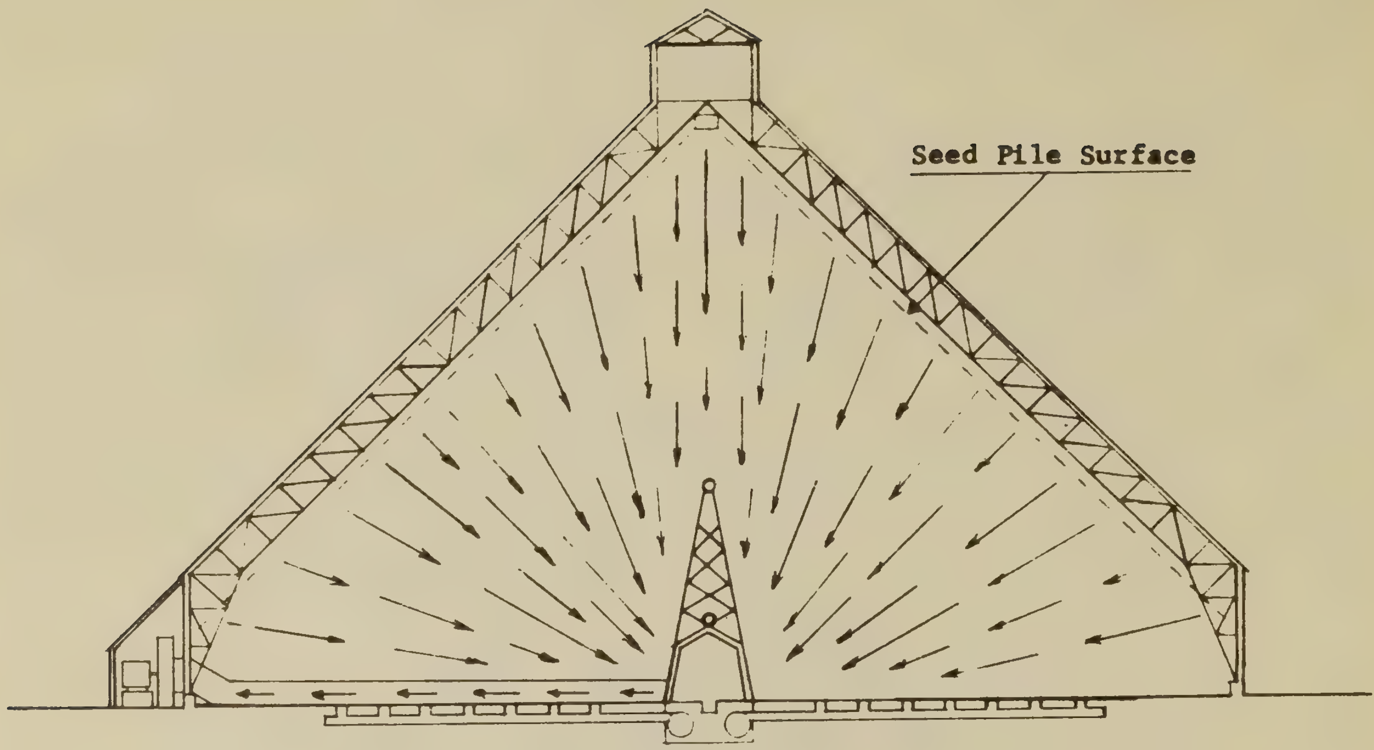


DIAGRAM #2

ends of the tunnel is necessary to prevent air entering by this route, thus maintaining efficiency overhead.

When the maximum capacity of a house is not needed the cost of stowing seed does not seem warranted for only a probable need to do so. Even so, to have stowed seed, the slight drying and compaction causes a shrinkage away from the roof which creates an air passage, and again the air flow takes on the pattern shown in diagram No. 1. Moreover, the openings caused by the corrugation of the metal along the foundation and the eaves of a typical house is approximately equivalent to a pipe six feet in diameter. This, in addition to the air seepage from the tunnel to the floor laterals, prevents any large volume of air from passing through the greater bulk of the seed pile. Again there is the possibility of heating above the tunnel.

To overcome this situation an experiment was made to obtain a suitable air flow through the area above the tunnel where the seed were hot. This was accomplished by closing both end openings of the tunnel about ten feet back with a bulkhead made of reenforced one inch lumber. Cracks and leaks were caulked with mud of a putty-like consistency.

The intake side of one of the lateral fans was piped through a bulkhead to exhaust the air from the tunnel, which in turn pulled the outside air through the entire seed pile. The temperature of the hot seed dropped 25° the first twenty-four hours.

So successful was this experiment that a permanent and improved installation was made the following summer in 1947.

This was accomplished by laying 24″ diameter by 36″ length concrete pipe in line from one side of the house to, and connected with, the tunnel, at the midway point. A concrete curb was poured on both sides of the pipe to anchor it and prevent it from rolling or shifting.

The fan, mounted outside the house and protected by its own enclosure is a 54″ Phelps fan powered by a 75 hp. motor pulling 81 amperes. Fan speed is 1315 r.p.m., and de-

livers approximately 10,000 c.f.m. Removable, portable bulkheads were made for installation on both sides of the duct opening into the tunnel. These may be adjusted so that either end half of the house, or sections in multiples of five feet from the center of the house, may be aerated at one time; thus permitting concentration of air through the desired area.

Again, a look at a cross-section of the house (diagram No. 2) will show why such an application is feasible. The distance from the tunnel to the outer wall is approximately the same as the distance from the tunnel to the overhead conveyor, or to the "catwalk." Actually the distance from the tunnel to any point on the surface of the pile is about the same, similar to the radius of a semicircle.

From this it would appear, perhaps, that when suction is applied to the tunnel, the air flow through the pile would be uniform at any given surface point. This would be true only if the density of the seed was constant. But density is greatest near the floor and diminishes as height is attained. Therefore the air flow is less near the floor and greater in the upper part of the pile. It is this area that has been the most troublesome, and can now, by this method be aerated.

It was not intended to supplant the existing floor laterals but rather to supplement it.

It should be borne in mind that air can flow either direction through the floor laterals and, in order to obtain maximum cooling in the upper part of the seed pile, the valves of the laterals should be closed when pulling air from the tunnel. Otherwise a seepage will occur from the laterals to the tunnel.

In the 13 years the Armour & Company Mills have used this tunnel aerating system, no serious heating of seed has occurred even upon storing seed with as high as 20% moisture.

The general practice is to cool the seed to about 40°F. as weather temperatures permit. When this is attained no further aerating is needed under normal conditions.

Regular temperature readings are maintained as a precaution. Should a spot develop an increase in temperature, it can readily be

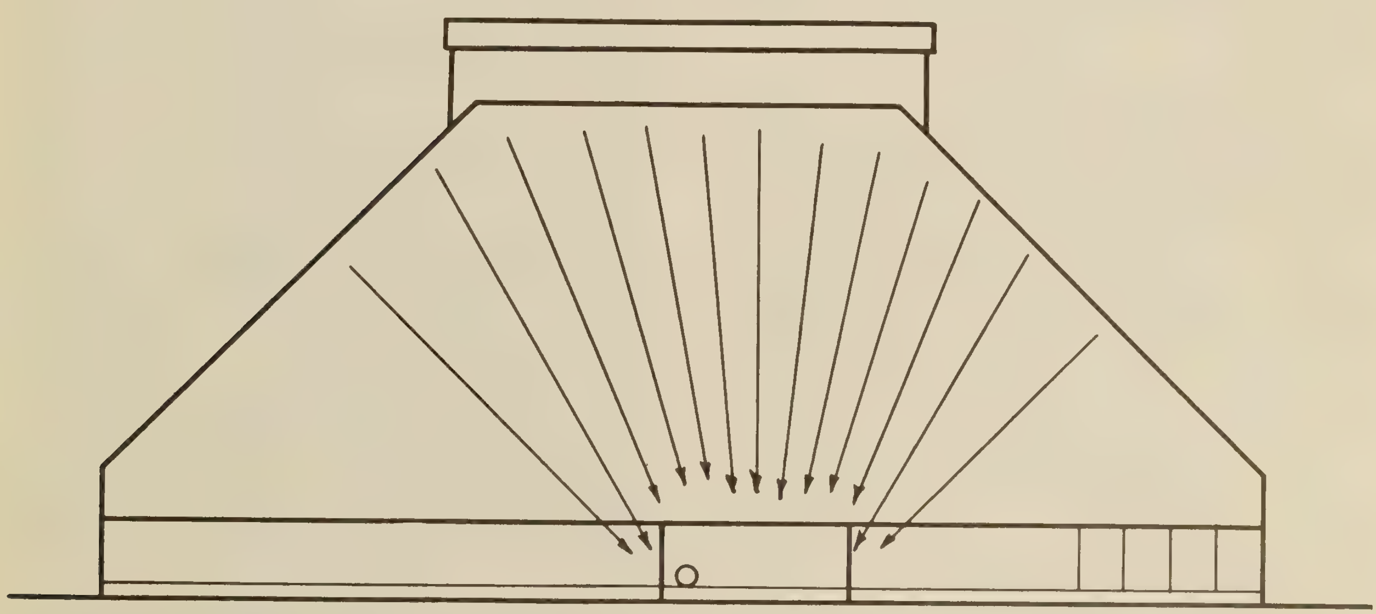


DIAGRAM #3

cooled by concentrating the air through the affected area provided, of course, the outside air is cool enough.

An additional advantage of this particular method worth mentioning is the fact that when seed are first received in the house no preparation, such as spreading the seed over the lateral boards for sealing, is needed. The seed can be dropped in the center of the house where the duct enters the tunnel, and cooling begun immediately, extending the bulkheads as the length of the pile increases.

Air-tight covers for the drag belt trench may be utilized to cool one section of the house while feeding out of another.

While no operating cost comparison has been made between the tunnel type cooling and the conventional floor laterals, it is estimated the tunnel fan is operated about 25% of the fan hours previously used in the lateral cooling with much greater efficiency, and costs, dependent upon the season, are between 1 and 2 cents per ton.

Cost of such an installation would depend upon the size of the house and upon local labor conditions. At the time the first installation was made some twelve or fourteen years ago the cost was approximately $3,000.

SEED CLEANING

E. A. Gastrock
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Cottonseed cleaning was a serious problem in 1952 when the first Cottonseed Processing Clinic was held. Around that time leaders in the Valley Oilseed Processors Association and other leaders in the cottonseed industry urged the Southern Division to study this problem. The Southern Division undertook the problem and reported progress at Superintendents' meetings, Short Courses and at Processing Clinics.

Today, improved cleaning methods are still needed. But, prevailing economics demands that proposed improved cleaning methods show a decided advantage as well as high efficiency and low investment and operating costs.

Based on completed research on cottonseed cleaning, SURDD now has a cottonseed cleaning method to offer cottonseed oil mills that should enable them to produce cleaner, higher grade linters. This method uses the principle of the ARS Cleaning-Belt. It has been described and demonstrated at previous clinic meetings. However, the results obtained since the last clinic meeting are most encouraging and emphasize the advantages of this method. These results have been achieved in actual runs on the 8′ x 10′ cleaning-belt largely by improving the opening and feeding operation.

It was recognized early in the research that the best separation of seed from foreign matter on the cleaning-belt depended heavily on separating the individual particles so that individual performance would result. Thus each particle rolls and tumbles or stalls out as its own weight, shape, size, etc., dictate.

The opener-feeder has two spiked rotors turning in opposite directions at about 1000 r.p.m. A uniform stream of trashy cottonseed falls between these spikes, which intermesh but do not touch. The cottonseed stream is separated into individual particles, and tossed up and around the sides of the feeder. The two streams of seed then cross in the space below the spikes and bounce from the sides. The trashy seed, in a particulate condition, then strike an inclined bouncing board before landing on the moving cleaning-belt.

From the opener the seed has an initially higher speed than the foreign matter. The belt texture accentuates this difference in speed. The livelier seed thus land in the accept bins at the lower edge of the belt. The foreign material tends to slow down and stall out and is carried to the reject bins at the side.

Typical results obtained with the improved opener at a feed rate of 25 tons per day of seed with a linters content of 10% are as follows:

Foreign Matter Content	Feed %	Accepts %	Reduction %
Stems	1.01	.14	87
Shale	.17	. . .	100
Boll Wall	.77	.41	47
Boll Bases	.41	.36	12
Total	2.36	.91	64

Four accept and four reject bins are provided for the cleaning-belt.

The accept bins are numbered A1 through A4 starting at lower right and moving left. The reject bins are numbered R1 through R4 starting at lower left and moving up. In these tests only 1.0 to 3.5 percent of the seed pass to the reject bins. More than 90% of these seed are in the R1 and R2 fractions and are low in quality. This small percentage may be sent to the hullers in order to recover oil and meal values from them. The balance of the rejects, R3 and R4, contains about 70% of the foreign matter removed and a negligible percentage (about 0.25%) of the original feed of inferior seed. This fraction may be discarded.

The belt texture has also been studied, and a more efficient one has been found. This new texture, a molded rubber pin sheet, has small rods 3/16 in. high spaced 5/32 in. on centers perpendicular to the surface. The tests show equal or slightly improved removal of stems, shale, and boll bases with the new texture but greatly improved removal of boll walls (up to 80%).

The tests of the new texture were made by determining the relative percentage of stalled out particles on a non-moving inclined surface covered with the texture. The pin sheet was the best out of 8 different textures studied. It is likely that even more efficient textures may be found or designed.

An additional development step is needed. The unit should be operated under its optimum conditions in direct comparison with conventional cottonseed cleaning equipment. Improved cottonseed cleaning by the moving-belt unit in such a comparison should give oil mill operators confidence to try the unit under mill-scale production conditions.

Experimental operation along these lines is in the planning stage.

Although the unit developed thus far is experimental in nature, it is not anticipated that any difficult or insoluble problems would be involved in building production models for oil mills.

Additional studies on textures and on the feeder should be profitable. Better textures now available should be actually tried on the 8′ x 10′ cleaning-belt. The comparative evaluation studies should indicate factors that are most important in a production model.

It should be relatively inexpensive to build and economical to operate a production model.

Initial trial of the unit as an accessory to conventional oil mill cleaning equipment is recommended.

The advantages of the new cleaning method may be summarized as follows:

1. Fines removal (sand, fine field trash, dust, etc.) is complete.
2. Free linters removal is practically complete.
3. The belt operates at relatively low speeds.
4. The unit has a low power consumption.
5. The cleaning efficiency is not particularly sensitive to changing nature and rate of feed.
6. The angle and speed of the belt may be quickly adjusted to obtain the best cleaning results.
7. Repassing will accomplish additional cleaning.
8. Seed passing to reject bins are low in quality.

COTTON LINTERS: UTILIZATION AND PROFIT REALIZATION*

Charles A. Montague, Jr.
Buckeye Cellulose Corporation
Memphis, Tenn.

Gentlemen, according to your program my topic this morning is to be a discussion of the possibilities of better utilization of cotton linters. In this discussion better utilization will be assumed to mean simply that utilization which will, over the years, yield you a greater revenue on the total volume of linters which you market.

In view of the fact that second cut linters are currently selling at some 4 cents per pound f.o.b. the mill, with no apparent building or excessive inventories, you may be wondering

* Presented by W. P. Lanier, Buckeye Cellulose Corp., in the absence of C. A. Montague.

why your program committee chose to include such a discussion in your program. However, if history repeats itself we will not be surprised to find that following this period of excessively high prices that lint and pulp prices fall precipitously due to declining demand. In view of this, perhaps the timing is appropriate.

Before discussing the prospects of better utilization of linters, it would be well to review briefly the past distribution of linters consumption. In doing this let's look first at the consumption of the total linter crop—first cuts, mill runs, and second cuts combined. An overall look at the consumption indicates that there are two general categories into which consumption may be divided. These are the chemical and the non-chemical areas. This first slide (slide 1) shows the distribution of total linter consumption between these two areas during the past five years. These are crop years 1954-55 through 1958-59.

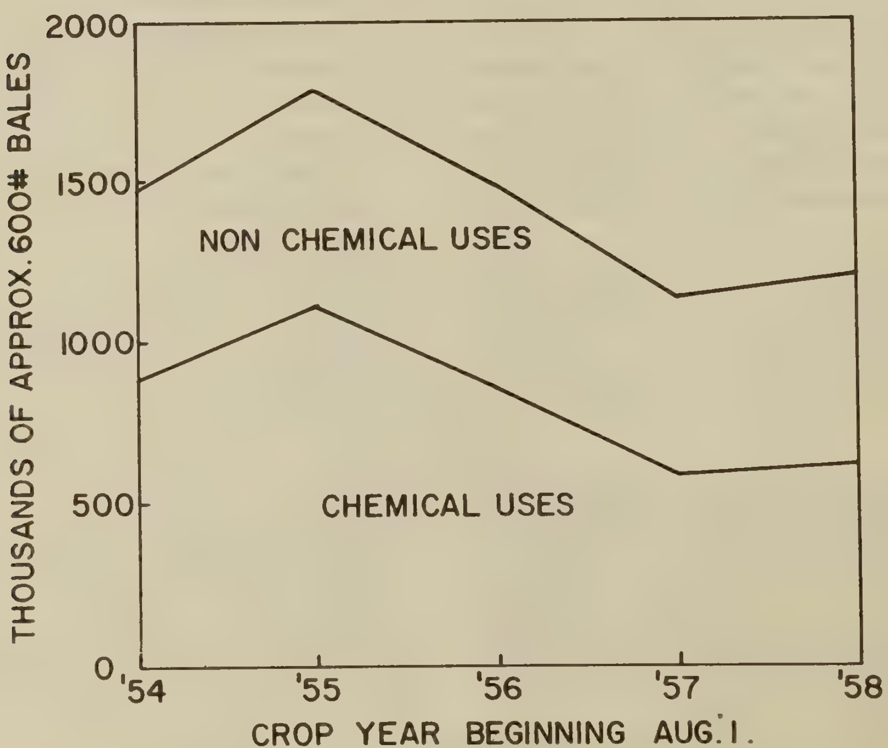
Over this period the distribution of linters production between the various cuts has been 23.4% first cuts, 5.5% mill runs and 71.1% second cuts. If we subtract the first cut and mill run fractions—essentially all of which have been consumed in non-chemical uses—from the above curve, we will obtain a new chart representing the distribution of second cuts only between chemical and non-chemical uses.

This resulting second chart (Slide 2) graphically illustrates the predominance of chemical consumption and the manner in which non-chemical consumption tends largely to remain constant. There are, of course, gradual changes resulting from changes in the price of raw linters relative to competitive materials.

From these charts we can appreciate the extent to which the chemical industry has been the dominant factor in the consumption of second cut linters. Chemical consumption has averaged 79.4% of total second cut consumption over the period. This being the case, I will address myself primarily to this portion of the linters market this morning. This is probably a valid approach in view of past performance and the fact that authorities predict that non-chemical usage will remain about level in the future assuming competitive price levels.

BREAKDOWN OF TOTAL LINTERS CONSUMPTION
BETWEEN
CHEMICAL AND NON CHEMICAL USES (ESTIMATED)

SLIDE 1



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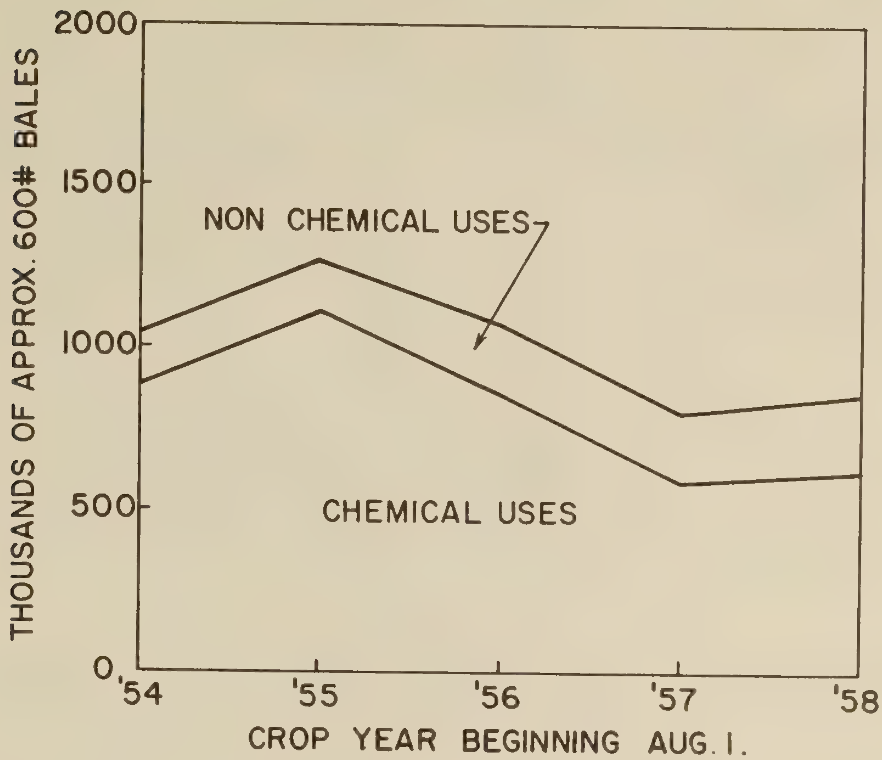
BREAKDOWN OF SECOND CUT LINTERS CONSUMPTION
BETWEEN
CHEMICAL AND NON CHEMICAL USES (ESTIMATED)

SLIDE 2



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Addressing ourselves to the chemical consumption we find that this can be broken down into a number of sub-uses. These next bar charts (Slide 3) will illustrate the average distribution during two years periods at the beginning and end of the five year period previously described. This averaging is done in an attempt to level out some of the effects of annual cycles and to attempt to establish the trend of consumption over the period.

From the charts it is obvious that substantial progress has been made in the diversification of linters consumption. This diversification has brought about significant growth in the plastics, paper and ether areas. It is in these areas that linters pulp continues to enjoy its primary advantages. By extending the trends indicated by the third chart, we should get some idea of a continuing trend of consumption distribution.

Let me digress here for just a moment to explain why I have used the trend of past consumption as the sole indicator of future consumption. I think I should do this since you may have expected me to advance some entirely new and different uses for linters.

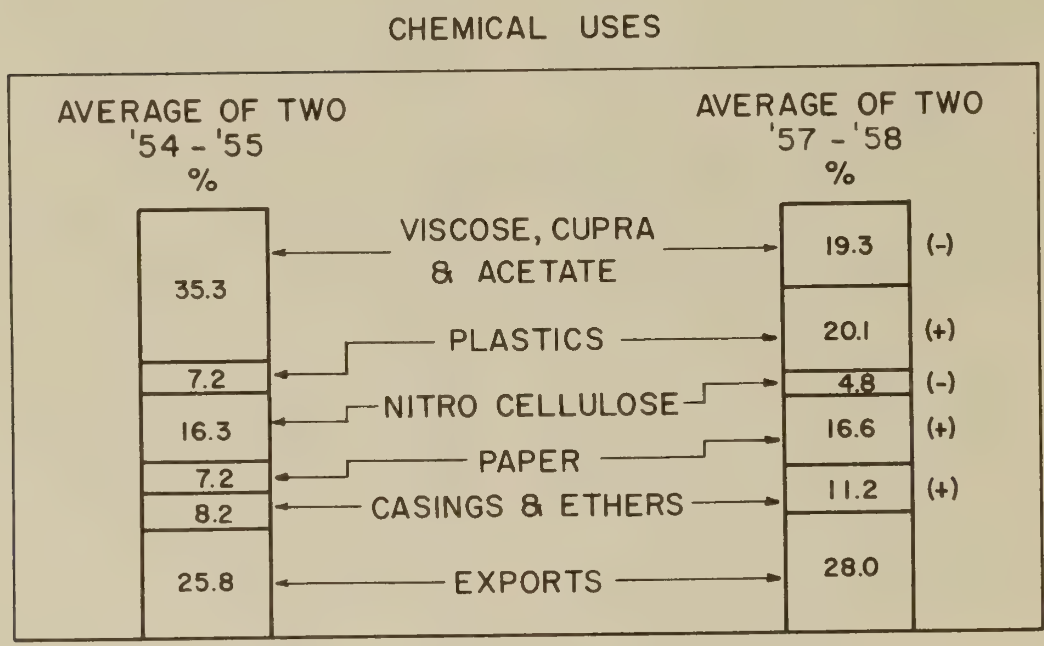
The reason I have done this dates back to 1957. At that time, as you will recall, we were just coming out of one of these periods of excessively high prices and vanishing demand. At that time our company felt that there was simply no other course but to find new uses for linters that avoid these periodic upheavals in price and demand.

In an attempt to do this A. D. Little, an outstanding laboratory, was commissioned to study the problem. Representatives were brought to our own research facilities, given whatever information we possessed and sent it back to their own group for further study of the problem.

What were the results? About this. There are areas such as the writing and electrical laminating paper fields where linters have unique advantages. These were already being pushed and the results of this are shown in our chart. In addition there were some highly specific areas where the high molecular order

COMPARISON OF ESTIMATED DISTRIBUTION
OF
SECOND CUT LINTERS CONSUMPTION

SLIDE 3



2/60

of lint cellulose was of advantage. These involved only extremely small tonnages. Beyond these there was the possibility that all hospital sheets, doctors' uniforms, etc., would soon be made of air lain linters.

As you know, this has not developed although there are some applications of this technique in existence. However, these largely employ the longer fibered cuts. All of this adds up to the fact that about the only reliable method of predicting the consumption in the near future is on the basis of past performance.

We must refer to any extension of the trend from the chart as one of "potential" consumption because several factors enter into the determination of whether this consumption ever actually materializes. In almost all of the listed use areas linter pulps have, over the years, enjoyed technical advantages. These have been related to you on many occasions and it hardly seems worthwhile to repeat them at this time. However, linter pulps have been experiencing increased competition in all of these fields as improved wood pulps have been introduced. These improved pulps have severely narrowed the technical gap that once existed and have brought with them advantages of their own. These are principally uniformly low cost and stable supply.

In view of the severe competitive situation that exists, the important thing to be gained from this usage chart appears to be not the increase in tonnage that is included in the specialty growth areas but rather that portion that remains outside these areas. This tonnage represents primarily the heavy chemical or textile grades which do and will, for the immediate future, continue to compete with improved wood pulps. They will do so enjoying only marginal technical superiority and accepting substantial price disadvantages.

The fourth chart (Slide 4) will show a comparison of significant quality and price relationships for competitive viscose pulps.

To expect that linter pulp is going to find acceptance at the indicated price differentials is unrealistic. This would be comparable to expecting to sell 98.4 proof whiskey at $7.00

a fifth when 97.4 proof was selling at $5.70. Believe me, this could be sold only to those with the most discriminating tastes.

This marginal portion of linter consumption is of particular importance to our industry since it represents the lowest priced utilization of linters yet is of such a volume as to mean the difference between complete utilization of linter production and the existence of severe surpluses. It is, and probably will remain, the lowest priced outlet due to the existence of the low priced wood pulps of essentially equal quality.

All that we have said would appear to lead us to two conclusions:

1. That the possibility of a substantially different distribution of the utilization of linters does not appear imminent, and
2. That the only path presently open to us for an improvement in the profit realization from linters must begin with the substantial volume of linters consumed in the heavy chemical uses which largely peg the base price of all linters.

We in the bleaching industry see the best chance of this as being through the elimination of the two main disadvantages of linters pulp —those of instability of supply and instability of price. These disadvantages give major consumers ample cause for reluctance to depend on cotton linters in areas where wood pulps are satisfactory. This means that linter pulps must be offered to these consumers at prices below their actual technical worth in order to induce their use.

This situation is substantially aggravated after extreme price fluctuations which have driven consumers to wood pulp. Following these periods, bleachers are compelled to offer pulps at new low prices to again stimulate consumption. These lower pulp prices inevitably bring with them lower linter prices on the volume of second cuts. These in turn pull down the price of all cuts. This low price is

Typical Chemical & Physical Properties of Competitive Linter & Wood Viscose Pulps And Their Current Market Prices

SLIDE 4

ATTRIBUTE		LINTERS	WOOD
Alpha Cellulose	%	98.4	97.4
Degree of Polymerization		910	1010
Rayon Yield	%	99.5	98.8
Ash	%	.05	.04
Silica	PPM	45	25
Calcium	PPM	42	25
Iron	PPM	9	6
Manganese	PPM	.10	.10
Copper	PPM	- - -	.6
Price (Delivered)	$/S.T.	240.00	195.00

the primary cause of the snowballing effect of cotton linter pulp consumption once it is back in use by the consumer. This low price then breeds in excessive demand and higher price.

The current attitude toward cotton acreage control would appear to be in the direction of alleviating the first of these disadvantages. Only you and the other cottonseed processors like yourselves can—through your marketing policies—alleviate the second.

Panel Discussion

Moderator: E. A. Gastrock

Members: James Hicky, Willis P. Lanier, A. Cecil Wamble, Walter Johnson

Seed Cooling:

MacGee: Has any consideration been given to moving air up through the cottonseed instead of down?

Hicky: In the past, this type of cooling proved ineffective.

Wamble: A long time ago, air was blown up through the seed until we learned better. A lot of seed was burned up. Blowing air up through the seed removes moisture from the bottom and condenses it at the surface of the seed pile. This seals the pile and stops ventilation.

Pryor: Do you make any effort to seal the tunnel?

Johnson: Bulkheads seal the ends of the tunnel and seed seals the small openings in the other sides.

Pryor: Is the drag belt covered?

Johnson: Yes, it is covered with seed.

Kidd: What horsepower did the fan motor have?

Johnson: 75 hp.

Blalock: How far do the lateral ducts extend; to within 10 feet of the walls?

Johnson: Yes.

Wamble: The length of the laterals depends on the house size and the pile of cottonseed.

Quinn: One of our plants had trouble with seed wetting and matting around metal lateral ducts. Has anyone else had the same experience?

Smith: Some two years ago, we had the same trouble. In our case, small openings caused the difficulty. The holes plugged, causing the seed to become wet. Wood slats were added to protect the holes and to keep the seed from coming into contact with the metal. We haven't had any further trouble.

Gastrock: Do the small openings cause the temperature to drop due to loss of pressure?

Allen: I don't know about the pressure loss, but the seed became wet.

Gastrock: For very high humidities, don't you think pressure drops could cause condensation? Was there any along the ducts?

Quinn: Yes, water was present.

Blalock: Probably, cooling of the metal caused the condensation.

Godchaux: Part of the heat loss was due to conduction through the metal.

Scherr: We had an unexpected fatty acid rise this season. Did anyone else have the same experience? If so, what do you think caused it?

Kidd: We had the same experience and credited it to this particular crop.

Kidd: What tonnage capacities do the diagrammed seed houses have?

Johnson: The diagrams are general. The capacity of our seed houses are 12,500 tons for the 100′ x 250′ building, 10,000 for 100′ x 200′ and 8500 for 100′ x 160′. The largest house had two fans and the others one.

Easley: We dried wet mats formed on the bottom by increasing the suction on the fans.

Sale: Years ago we found that when filling a seed house, free lint formed a mat and filled holes in uncovered ducts. The holes plugged when the seed was piled on top of the mat. The ducts first covered with seed, gave no trouble. The holes remained open. To prevent

trouble, we covered all ducts with seed when starting to fill the house.

Gastrock: Apparently, there are a number of housekeeping and operational details that are important for maintaining an efficient and troublefree seed house.

Seed Cleaning:

Ginaven: Trash removal figures were given for a feed rate of 25 tons cottonseed a day. What would the efficiencies for trash removal be at a rate of 50 tons a day?

Gastrock: This is relative, based on the kind of seed being cleaned. The setup was based on 2.36% trash in feed, a very dirty seed. It depends upon what type of trash you want to remove from the seed.

Ginaven: If composition of the feed changes, how will the trash removal efficiency be affected?

Gastrock: Generally speaking, the cleaning-belt is not particularly sensitive to these changes unless they are large. Somewhat lower efficencies may result if the trash content increases and vice versa. If a higher percentage of seed can be tolerated in rejects, then the capacity may be increased. If the nature of the trash content changes, the cleaning efficiency may also change.

Orr: Will this machine be set up for the short course at College Station, Texas?

Wamble: It is doubtful. Not this year, but possibly for next year's short course.

Kidd: What is the optimum belt speed?

Gastrock: 200 ft./min. Its range of speed is 150 to 300 ft./min.

Smith: What would it cost to build such a machine?

Gastrock: At present we do not have this information. However, it should not be an expensive machine to build. It would probably be less expensive than units now in use. The unit is simple, consisting of a frame, 2 rollers and a drive using approximately 2-½ hp.

Orr: Was your machine designed to stand hard service?

Gastrock: No. Our machine was built to test a principle. Our use showed little or no wear of the belts. The machine was not built for long life.

Smith: Is there any trouble in keeping this wide belt properly aligned?

Gastrock: No, four V-belts riveted to the undersurface of the belt maintained the alignment. Probably, two belts may be sufficient. For commercial machines, it is anticipated that the V-belts could be a molded part of the large belt.

Pryor: For a 100 ton per day capacity, would one large or several small units be used?

Gastrock: Multiple units would be used. Two units, assuming a 50 ton a day capacity, could be installed one over the other in a plant.

Linters:

Orr: When looking for new linters markets, it was thought that linters might be used to replace rags. Has any progress been made?

Lanier: There has been a slight increase in the use of linters for this purpose.

Spadaro: Has the development of chemically modified linters increased the overall utilization of linters in papermaking?

Lanier: To my knowledge, our end results show limited increase.

Baldwin: I am not qualified to speak on this matter. Its out of my field.

McClure: We have modified linters on the market. Though we are still trying we cannot produce them as economically as we would like to. Hercules is producing and selling the greatest quantities of these materials. They have patents covering their processes.

Anony.: What are the differences between linters and chemically modified linters?

Spadaro: One use of textile cuttings in papermaking is to increase the

strength characteristics of paper. Linters as such do not impart the strength characteristics attainable with textile cuttings. Chemically modified linters are linters which have been chemically treated to increase the strength of the papers made from them. Hydroxyethylation is presently the method most promising and most widely used by the bleachers or pulp producers. Good textile cuttings are in short supply because of contamination by synthetic fibers. Consequently there is a market for chemically modified linters.

Moore: At what price would linters have to sell for to compete with wood pulp?

Lanier: That is variable and depends on a number of factors. One user says he can pay $9.00 a ton above that for wood pulp. The present price differential is expected to cause a shift to wood pulp, which may be substantial. The increased use of cotton linters is tied in with world wide pickup in fiber consumption. Because of the increased demand, the price of the linters has risen. Demands for cotton lint have also increased.

Gastrock: Would improved seed cleaning reduce your processing costs and help you?

Lanier: Yes, to some extent. We have had to install linters cleaning machines. Cleaner linters would reduce costs.

Pons: Has anyone thought of treating linters to make them flame resistant, for use in paper?

Lanier: We have not done this.

Spadaro: Paper makers are now producing flame resistant paper from wood pulp. It does not appear economically feasible to use linters for this purpose.

Pryor: Taylor Bedding Co. has produced flame resistant linters for making mattresses. They were also used as an insulating material, weren't they, Cecil?

Wamble: Yes, to the best of my knowledge.

Spadaro: This company no longer produces treated linters for insulation as they could not compete with the natural products, i. e., rockwool.

Fisher: We have a comprehensive and far reaching research program on cotton lint. Our chemists have learned to modify cotton lint so as to give it any desirable property. They have learned to make it stronger or weaker, water soluble or water resistant, more or less resilient, flame resistant, rotproofed, soil resistant, water repellent, and softer. In fact, we can do almost anything to it. There is a great deal of this information available and perhaps linters processors could make use of some of it.

Gastrock: All this work has made cotton lint a more popular fiber. By analogy linters have also moved along.

Resolutions

1. **Be it Resolved**—That we express our appreciation and thanks to Chairman Robert Patterson, Program Chairman Lawrence Hodges and Committee Members for the time and effort devoted to the preparation of the excellent program presented at this the Ninth Clinic. We also express our thanks to those appearing on the program.

2. **Be it Resolved**—That we desire to express to Dr. C. H. Fisher, Director, Mr. R. M. Persell, Assistant Director, and the staff of the Southern Regional Research Laboratory our sincere thanks for the hospitable and kindly manner in which we have been accomodated during our visit here and the further desire that this most pleasant association may be continued.

3. **Be it Resolved**—That we commend the Hidden Oil Loss Committee, headed by Mr. J. H. Brawner, for the time given and work performed in an effort to solve this perplexing problem. We would also recommend the inclusion in the body of the General Resolutions the following:

Resolution From Hidden Oil Loss Committee

Be is resolved that the members of this Clinic recommend as a group that the U. S. Southern Regional Research Laboratory make a study of the analytical methods that may be involved in the causes of hidden oil losses, the detection of these losses, and their measurement.

J. H. Brawner, Chairman

We further recommend that this Committee remain effective in an advisory capacity and also in a position of availability in the event of further need of its services.

4. **Be it Resolved**—That we commend and congratulate Dr. C. H. Fisher, Mr. E. A. Gastrock and staff members responsible for the successful completion of a study on the cleaning of cottonseed which has developed a method and device that shows considerable promise in that field in the immediate future.

5. **Be it Resolved**—That the value of the Cottonseed Processing Clinics has been established as evidenced by the wide spread interest and attendance. **THEREFORE, Be it further Resolved** that these meetings be continued as a benefit to the economy of the cotton growing industry.

Respectfully submitted,

Jack Kidd
Dalton Gandy
Ralph Woodruff, Chairman

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W. D. Baldwin, Hercules Powder Co., Wilmington, Del.
Hill Blalock, Riverside Oil Mill, Marks, Miss.
J. H. Brawner, Wesson Oil & Snowdrift Co., New Orleans, La.
Dean K. Bredeson, French Oil Mill Machinery Co., Memphis, Tenn.
William Brew, Ralston Purina Co., St. Louis, Mo.
A. H. Burner, The French Oil Mill Machinery Co., Piqua, Ohio
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Woodson Campbell, Supt., Mississippi Oil Mill, Hollandale, Miss.
W. T. Coleman, Western Cottonoil, Abilene, Texas
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